The Journal of ELECTRICITY POWER and GAS

DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

VOL. XIII.—No. 5 SAN FRANCISCO, CAL., MAY, 1903. {YEARLY SUBSCRIPTION - $2.00 {SINGLE COPIES - 25 CENTS

1889 PARIS EXPOSITION MEDAL FOR RUBBER INSULATION

OKONITE TRADE MARK.

1893 WORLD'S FAIR MEDAL FOR RUBBER INSULATION

SOLE MANUFACTURERS OF

OKONITE WIRE

THE STANDARD FOR RUBBER INSULATION

OKONITE TAPE : MANSON TAPE

CANDEE WEATHER-PROOF WIRE

CANDEE (PATENTED) POTHEADS

THE OKONITE COMPANY, Ltd.,

Willard L. Candee, H. Durant Cheever, Managers
Geo. T. Manson, General Superintendent
W. H. Hodgins, Secretary

253 Broadway
NEW YORK

WESTON

Illuminated Dial Station Instruments

These instruments are constructed upon the same general principle as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger and the working parts are inclosed in a neatly designed dust-proof cast iron case which effectually shields the instrument from disturbing influences of external magnetic fields.

LIBRARY OF CONGRESS RECEIVED MAY 26 1903 COPYRIGHT ENTRY

Weston Electrical Instrument Co.

Waverly Park, NEWARK, N. J., U. S. A.

New York Office: 74 Cortlandt Street

BERLIN: European Weston Electrical Instrument Co., Ritterstrasse, 88.
LONDON: Elliott Bros., Century Works, Lewisham.
PARIS, FRANCE: E. H. Cadiot, 12 Rue St. Georges.

Constant Meese, President.
F. Gottfried, Secretary.

Meese & Gottfried Company.

ENGINEERS AND MACHINISTS

Nº 167 to 179 FREMONT STREET.
TELEPHONES: 3 TRUNK LINES. MAIN 847

SPECIALTY.
POWER TRANSMITTING MACHINERY AND ALL PERTAINING THERETO.
AGENTS FOR LINK BELT MACHINERY CO., CHICAGO.

SAN FRANCISCO.

VULCAN ICE MACHINES

Plate Process Ice-Making Plants

For Making Clear Ice With Electric Power

VULCAN IRON WORKS

505 Mission Street SAN FRANCISCO

The General Electric Company's

Modern Arc Lamps

Perfect Diffusion of Light

For Indooors **For Outdoors** **Giving Clear Shadowless Effects**

General Offices: Schenectady, N. Y.

San Francisco Office, Claus Spreckels Building. Portland Office, Worcester Building. Denver Office, Kittredge Building. Los Angeles Office, Douglas Building.
Salt Lake City, 25 East First South Street.

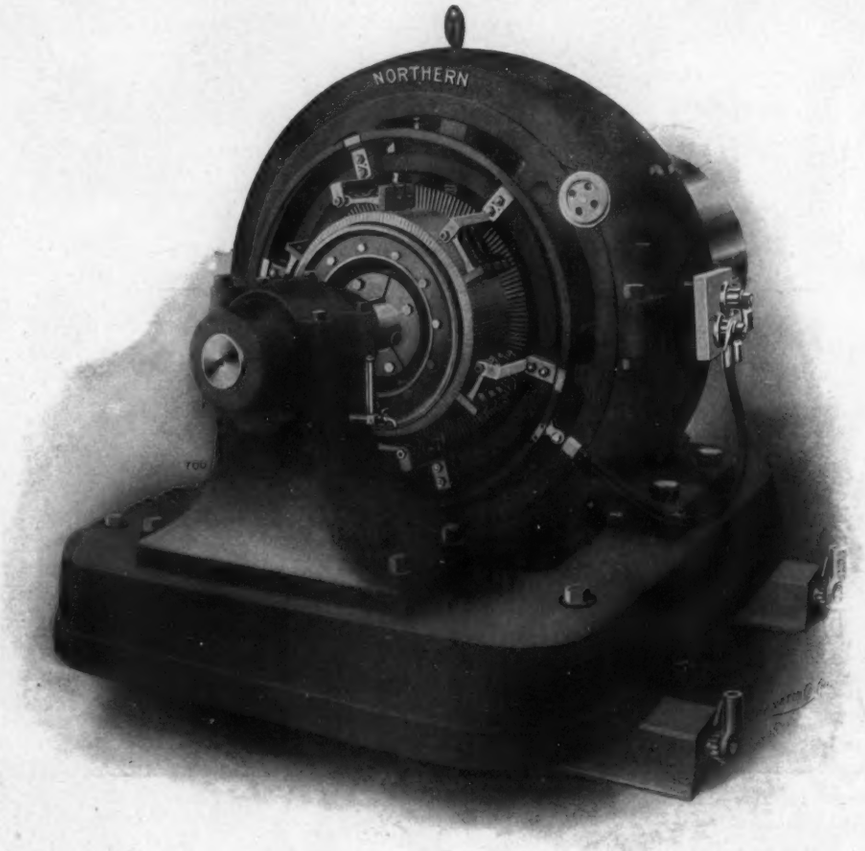
INDEX TO CONTENTS PAGE VI. ADVERTISERS' INDEX PAGE XVIII.

Simplicity

The simplicity of Northern Electrical Apparatus is no mere "talking point" for salesmen.

This fact is very apparent when "trouble" demands partial or complete disassembling of the machine.

BOOKLET 931 TELLS MORE; SENT FREE



15

Northern Generators and Motors are built in all standard sizes; in belted and direct-connected types; to perform in accordance with the specifications of the American Institute . . .

Northern Electrical Manufacturing Co.,

MADISON, WIS., U. S. A.

JNO. MARTIN & CO., Pacific Coast Representatives

31-33 New Montgomery Street, San Francisco, Cal.

Pioneer Building, Seattle, Wash. *511 Douglas Building, Los Angeles, Cal.*

LIBRARY OF CONGRESS,
...ies Received
25 1903
...ght Entry
XXc. No.
...PY B.

The Journal of Electricity, Power and Gas.

Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XIII. SAN FRANCISCO, CAL., MAY, 1903. NUMBER 5

California Petroleum and Its Use as Fuel.

BY A. M. HUNT.

THE existence of petroleum in California has been known from the earliest days, although its production in quantity sufficient to command attention as one of the important resources of the State dates back comparatively few years. The Indians utilized it for various purposes in the form of asphaltum, and the early Catholic fathers employed it in roofing their missions and other buildings.

Andreas Pico, in 1855, distilled petroleum obtained from Pico Canyon, near Newhall, Los Angeles County, on a small scale, and in 1856 a company commenced work on the La Brea Ranch, and tried to refine the crude oil. In 1857, an attempt was made to produce an illuminating oil at Carpenteria, and there are records of various other attempts, previous to 1860, which were not successful.

Professor B. Silliman made the earliest scientific report on petroleum in California in 1865, and this led to a considerable oil excitement during the next few years, but owing to the limited knowledge then available as to the geological conditions connected with oil fields, and the inadequate tools available for drilling, there were more disappointments than successes, and even as late as 1870 the annual output amounted to only 3600 barrels.

The subjoined table, taken from the report of the Chamber of Commerce of San Francisco for 1902, gives the annual production for the past thirty-two years, and the value based on selling prices at tide water. It illustrates the remarkable growth of this industry during the past years, and shows what few of our people know, that the value of the crude oil product of the State for the year 1902, apart from the allied products of asphaltum and natural gas, was approximately two-thirds that of the entire gold product, and bids fair within a short time to surpass it.

TABLE GIVING ANNUAL OUTPUT OF PETROLEUM IN CALIFORNIA.

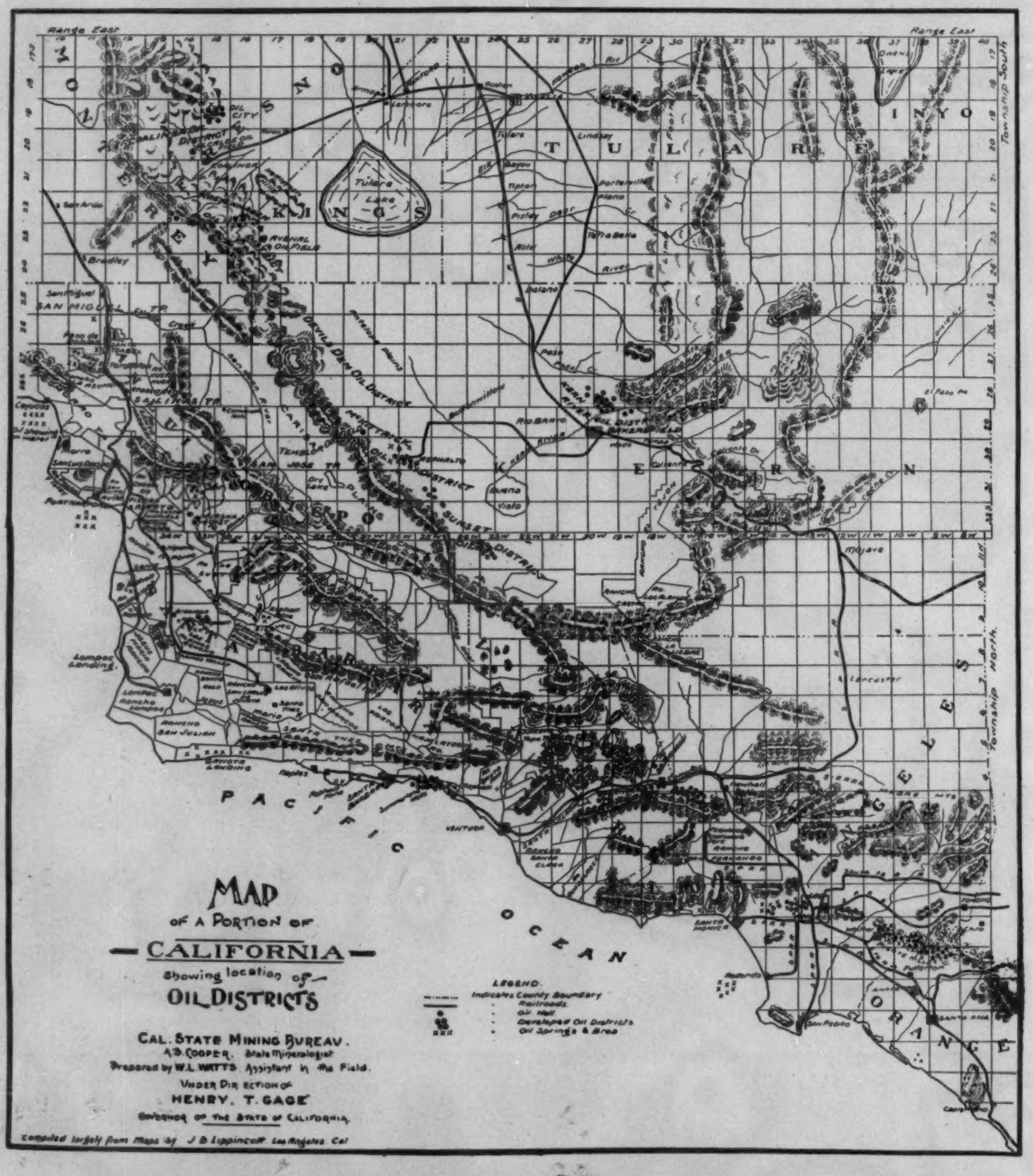
Year	Barrels	Value	Year	Barrels	Value
1870	3,600	$5,125	1887	678,572	$1,357,144
1871	5,200	7,370	1888	690,333	1,380,666
1872	6,500	9,876	1889	303,220	368,048
1873	7,200	10,920	1890	307,360	384,200
1874	7,700	11,540	1891	323,600	401,264
1875	8,400	12,090	1892	385,049	561,333
1876	9,600	15,410	1893	470,179	608,092
1877	12,750	18,140	1894	783,078	1,064,521
1878	15,227	22,780	1895	1,245,339	1,000,235
1879	19,858	29,672	1896	1,257,780	1,180,793
1880	42,399	68,450	1897	1,911,569	1,918,269
1881	99,862	130,678	1898	2,249,088	2,376,420
1882	128,636	172,730	1899	2,677,875	2,660,993
1883	142,857	207,540	1900	4,329,950	4,152,925
1884	262,000	428,600	1901	8,754,500	7,487,600
1885	325,000	613,920	1902	13,692,514	10,269,385
1886	377,145	642,785			

Valuations are based on selling prices at tide water.

In 1887, the State Mining Bureau first took up the subject of the petroleum fields, and has issued a number of bulletins filled with data of the highest value with reference to the industry. Careful investigations of the geological formations pertaining to the occurrence of petroleum have been made and collected in such form as to permit a general study of the industry. These bulletins owe much of their value to the accurate and painstaking work of W. L. Watts, for a number of years assistant in the field to the State Mineralogist.

Practically all the oil fields which furnish oil in commercial quantity in California are located south of an east

THE M'KITTRICK OIL DISTRICT OF CALIFORNIA, VIEWED FROM THE NORTH



and west line running through the towns of Visalia and Hanford. Within this territory the productive fields are distributed in the foothills of the Sierras near the eastern end of the San Joaquin Valley, on the eastern slope of one of the coast ranges, and in other portions of the coast ranges which traverse Santa Barbara, Ventura, Los Angeles and Orange counties. It must not, however, be taken for granted that the oil-yielding formations are confined to the above mentioned localities, for they constitute a large portion of the mountains composing the Coast Range system. In many places they form the bedrock underlying the alluvium of the valleys. Neither does it necessarily follow that wherever these oil yielding formations occur oil will be found in paying quantities, but it is a reasonable conclusion that there are in California numerous areas wherein productive oil fields will be discovered.

The following excerpt from the report of the Chamber of Commerce of San Francisco, Cal., gives data as to the

distribution of production of petroleum in California in 1902, and deserves careful reading:

The output of petroleum oil in California during 1902, and the number of wells in operation at the close of the year are shown as follows:

Producing Fields	Producing Wells	Production Barrels
Coalinga	19	504,545
Santa Maria	5	100,636
Midway	2	50,180
Sunset	24	142,630
McKittrick	37	597,600
Kern River	322	8,646,109
Summerland	228	94,900
Newhall, Santa Paula and Ventura	370	609,000
Los Angeles	926	1,074,655
Whittier	76	543,450
Fullerton and Brea Canyon	98	1,201,909
Puente	45	126,900
Total	2,152	13,692,514

Average daily production for the year, 37,513.

In consequence of the insufficiency of transportation facilities and the want of a market at prices at which the oil could be laid down at tide water, quite a number of wells were shut down during several months of the year. This was the case with the following wells in the districts named:

Santa Paula	13
Coalinga	55
Kern River	245
McKittrick	40
Sunset	55
Midway	16
Total of capped wells	424

At the close of the year wells were being drilled in producing fields as follows:

Newhall, Santa Paula and Ventura	23
Puente	3
Los Angeles	11
Summerland	2
Coalinga	5
Whittier	12
Fullerton and Brea Canyon	22
Kern River	28
McKittrick	8
Sunset	10
Santa Maria	3
Midway	11
Total	138

Stocks of oil in tankage and reservoirs, 3,850,000 barrels.

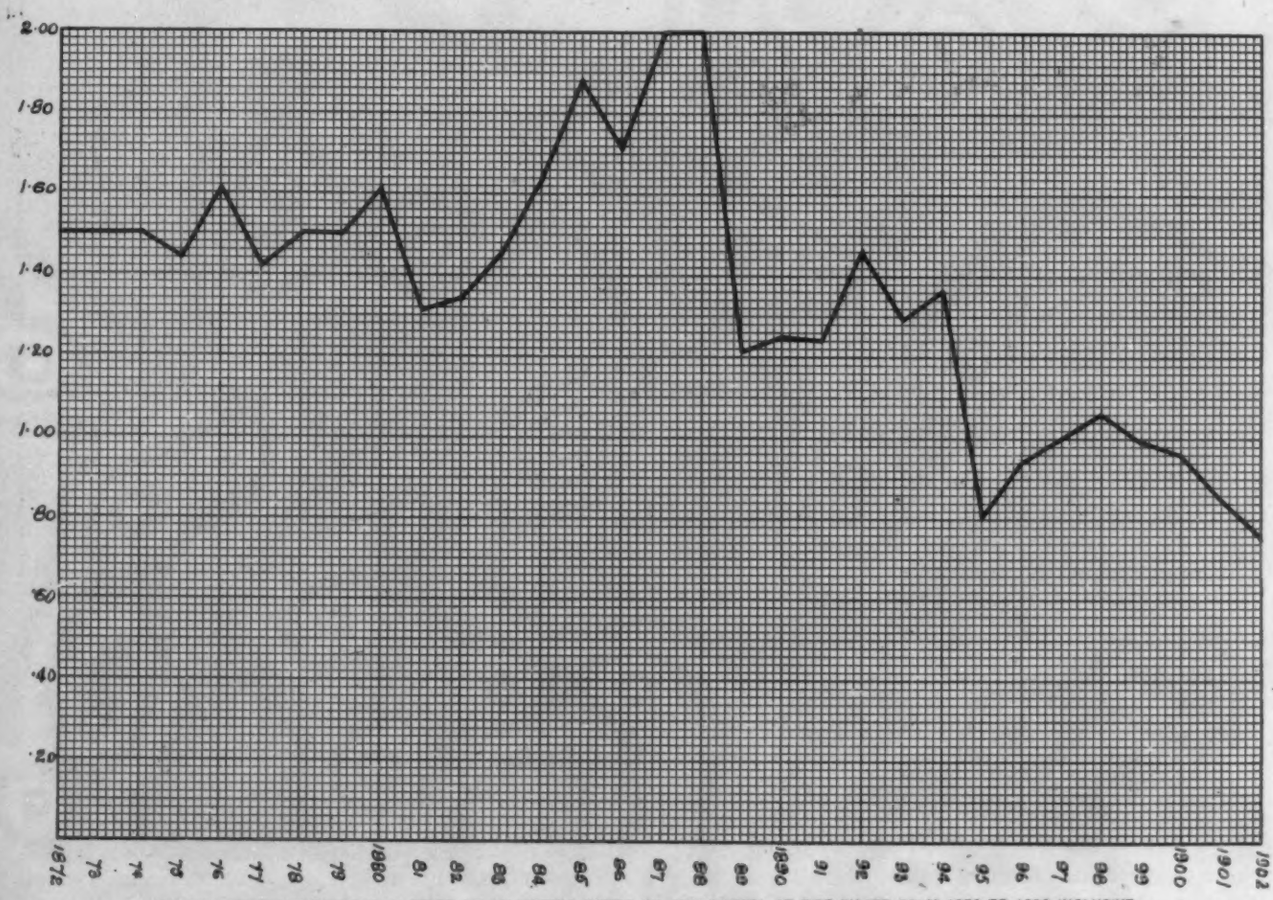
The production of the State varies in gravity from nine degrees Baume, the lowest gravity in the Sunset field, to thirty-eight degrees Baume, the highest gravity in the Newhall field.

The depth of producing wells ranges from 200 feet at Summerland to 2500 feet at Fullerton.

The tables given show the overwhelming importance of the Kern River field in the production of the State, and the rapid increase of output during the past three years is due to its activity.

The tables further show that approximately 20 per cent. of the producing wells are capped, and that over 43 per cent. of those in the Kern River field are shut down.

The facts disclosed prove conclusively that during the past year the present wells were more than able to supply the demand, and as the demand continues to increase, as it undoubtedly will, the output can be increased to meet it even without the development of new districts. Very



CURVE SHOWING VARIATIONS IN PRICE OF CALIFORNIA CRUDE OIL PER BARREL AT TIDE WATER FROM 1872 TO 1902 INCLUSIVE

few large flowing wells have been struck in California, and the character of the wells and their past records argue strongly in favor of permanency. The celebrated wells of Beaumont, Texas, were enormous producers when first drilled, but the reports of the past year show that they have fallen of rapidly in production, presenting a condition that has no parallel in the California fields.

The market for petroleum as fuel is ever growing. Increased demand for power is constantly being made, and as the output of petroleum becomes greater, and as fuel users become assured as to the permanency of the supply, greater and greater use will be made of it. Within the past few years many of the railroad locomotives have been arranged to use petroleum fuel, and there is a decided tendency to introduce its use on steam vessels. In fact a number are so fitted at the present time.

The Union Oil Company of California has been one of the greatest factors in developing the industry in this State, and has always been to the front in developing new territory. It owns a large number of wells, and controls the product of a number of others. It operates a refinery at Oleum, on San Francisco Bay.

The Associated Oil Companies control a large amount of producing territory, and the formation of this company has been an important factor in bringing about a more stable market condition than existed for several years after the Kern River field became a producer. Its activity has been limited almost exclusively to the fuel field.

The Standard Oil Company, so far as known, has not become interested directly in oil lands. It has erected large tankage in all the main producing fields, and bought oil from the producers in great quantities. It has erected a refinery at Point Richmond whose capacity is being increased. To serve this refinery it has built a pipe line, approximately 300 miles long, from the Kern River field, and will be a heavy buyer of the crude material.

There are numerous independent companies, and the conditions are such as to assure a healthy competition, which guarantees a reasonable price to the consumer, when taken in connection with physical aspects of the fields.

Practically all the petroleum of California is what is known as asphaltum base oil, and the major portion of it is quite heavy and contains only a small percentage of gasolines and kerosenes. Its value for refining, on this account, will have very little tendency to increase the price, and its main use will always be for fuel purposes.

The question is very frequently asked as to how many barrels of oil are equivalent to a ton of our ordinary coast coals. The answers given vary greatly. Taking the physical data, a comparison is fairly easy. A gallon of oil that will weigh 7.88 pounds will contain approximately 18,700 British thermal units per pound. A pound of average coast steam coal will contain approximately 13,500 British thermal units. A short ton of such coal would be equivalent in heat value to four and one-third barrels of the oil. In actual evaporative work this figure may be slightly reduced, owing to the facts that more perfect combustion may be obtained with the oil and with less excess of air. I do not think, however, that it is safe to place this figure at less than four barrels, unless the coal used as a basis of comparison is decidedly inferior. The figures of two and one-half to three barrels sometimes given by over-enthusiastic oil men must be set down as "fairy tales."

The relative value of the oils from different districts, and those of different specific gravities, is a matter that

A LAKE OF OIL IN THE M'KITTRICK OIL DISTRICT, CALIFORNIA

PROPERTY OF THE CALIFORNIA STANDARD OIL COMPANY IN THE M'KITTRICK DISTRICT, CALIFORNIA

often causes much discussion. Those who have light oils to sell put forth the statement that a pound of their oil has greater heat value than the heavy oils. This is undeniably true, but oil is always sold by volume instead of weight, and a gallon of the heavier oil will contain as many heat units as a gallon of the light oil. This statement may be accepted as true for oils of the range of those usually sold on this coast for fuel.

The writer has for over two years been operating a large electric plant in San Francisco. During one year oil averaging about fifteen degrees Baume was used as fuel, during the succeeding year oil averaging about nineteen degrees Baume. The oil used was accurately recorded, and the station output was registered by integrating meters that were checked from time to time. The average kilowatt-hours generated per gallon of oil burned was practically the same during the two years, and the conditions affecting economy of operation did not vary materially. A test of such duration, and under such conditions, is of more value than any amount of argument, and fully bears out the statement made above.

The lighter the oil the more readily it will flow in the small pipes of a burner system, and the more readily it can be pulverized for burning.

Some years ago, I used for a period of six months a large quantity of oil of a gravity of twenty-seven degrees Baume. Using this oil it was very easy to get an almost flameless combustion in the furnace, the oil being easily sprayed and broken up. I have many times tried to obtain similar results with the heavy oils of about fourteen to fifteen degrees Baume, but without success.

Burners of various types have been invented by the thousands, and each particular inventor believes and claims that he can evaporate more water per pound of oil

ANOTHER VIEW OF THE PROPERTY OF THE CALIFORNIA STANDARD OIL COMPANY IN THE M'KITTRICK DISTRICT, CALIFORNIA

A FLOWING WELL OF THE GIANT OIL COMPANY, IN THE M'KITTRICK DISTRICT, CALIFORNIA

than any other. While correct principles must be employed in making a burner, any device that will distribute the oil in the furnace, and in a state of fine sub-division, accomplishes all that a burner can be asked to do. It should do this with the use of as small an amount of the spraying medium as possible, and deliver it as uniformly as possible over the area of the furnace, and without direct impingement of the flame on the iron of the boiler. A burner that may be well adapted for one type of boiler may prove unsuccessful with another. A matter of equal, if not greater, importance than the type of burner in determining the success of fuel oil burning, is proper construction of furnace and admission and distribution of air. Considerable attention has been given to these points during the past year, and if a brick can be obtained that, when built into an arch, will stand up under the extreme heat of the direct action of the oil flame, the problem will be easy of solution. The new electric furnace product known as "siloxicon" promises to be such a material, and the makers state that they are now in a position to deliver it in quantities.

The writer has for several months been experimenting with a method of burning oil under boilers that has been eminently successful. On the ash-pit floor one or more flues (depending on the width of the furnace) are built, extending from the ash-pit door back to the bridge wall, which closes the flues at the rear end. These flues are about six inches square inside, and are built of fire-brick.

THE STRATTON WELL, IN THE MIDWAY OIL DISTRICT, CALIFORNIA

The sides of the flues are pierced with ports at intervals of about eight inches. A common burner of the concentric tube type is placed at the front end, so as to discharge the oil into the flue. When the burner is started, and the oil ignited, the interior of the flue soon becomes heated, and the flame issues through the side ports without any of the blow-pipe effect and action common to practically all open types of burners. The injector action of the burner carries air in with the sprayed oil, which furnishes sufficient oxygen for its partial combustion. The oil that is not consumed in the flue is gasified by the heated interior, and passing out through the ports is consumed in the open furnace, additional air being supplied through other flues.

The construction can be adapted to any kind of boiler, and it comes the nearest to bei- g a "fool proof" system of oil burning of anything with which I am acquainted.

A number of carefully made tests have been conducted with this arrangement under Babcock and Wilcox boilers, and the average evaporation is over 15.6 pounds of water per pound of oil from and at 212 degrees Fahrenheit.

In connection with these tests a Uehling-Steinbart pyrometer was used to determine the temperature of the furnace. This instrument is a recording one, and its records show very plainly one great advantage of oil fuel, viz., practically absolute uniformity of furnace temperature at about 1950 degrees Fahrenheit.

This flue form of construction lends itself admirably to the design of heating furnaces, and it is proposed to apply it to a hearth type of furnace for melting cast iron. The supply of air can be regulated in such a way as to give a reducing or oxidizing flame, and I can see no reason why the foundries on the coast should not use oil fuel instead of coke, with consequent reduction in expense of melting their iron.

The low price of crude oil during the past two years has entirely changed the fuel situation on the coast. It has very materially reduced the cost of power produced from steam, and has made it possible in many locations and under certatn conditions of load factor to compete with transmitted power from water power stations. It is not contended that the transmitted power has not its own field where it will always control the situation, but it is stated as a broad contention that given the conditions of load such as exist in San Francisco today in the best equipped central stations, and with oil at prices at which long term contracts have been made, steam-generated power can more than hold its own.

Another field in which cheap fuel oil is making itself felt is that of gas making. Carburetted water gas requires in its production a certain amount of distillate or light petroleum, but the fuel used for generating the heats and producing the water gas is hard coal or coke. A process has been in use for a number of years which does away with the necessity for using coal, and requires only the use of the heaviest crude oil. Since the reduction in price of the petroleum, this process has been introduced into a number of the smaller gas plants in the State, and lately in the city ot Oakland. If conditions as to price of fuel oil remain approximately as they are, it is safe to say that the bulk of the gas used, wherever oil is available, will be made entirely from that article.

It also seems probable that the near future will bring out internal combustion engines using crude oil directly in the cylinder with a degree of economy that will entirely outclass the steam engine.

The world's available fuel oil supply has largely increased during the past few yea-s. Within that period California has become an important factor, and seems destined to be even a greater one. The oil fields of Borneo are yielding large quantities. Discoveries have been made in Alaska which indicate that it will in the near future become a large producer, and the tale is not yet told of what the limit will be.

Petroleum From a Chemist's Standpoint.

BY PROFESSOR EDMOND O'NEILL.

FROM a chemist's point of view, petroleum is one of the most interesting of substances. It may be studied from several standpoints. First, its origin; second, its distribution; third, its exploitation; fourth, its properties; fifth, its uses. Any one of these questions will serve for a lifetime of investigation. All the facts concerning any subject are ascertained usually with great difficulty, and at the cost of much time and effort. The oil problem is of such recent occurrence that as yet comparatively little is known about it, but little by little knowledge is being accumulated, and it will be the object of this paper to give briefly, from a chemist's standpoint, some of the facts which may be of interest to a general reader.

First, in regard to its origin. The theories in regard to the origin of petroleum are numerous. They may be divided into two classes. First, from inorganic sources, and second, organic sources. The inorganic theory is briefly as follows. Metallic bodies combine at high temperature with carbon with formation of carbides. The carbon is furnished by carbonic acid, which in contact with another metal at very high temperatures, is decomposed, the oxygen uniting with the metal to form oxides, and the carbon combines with the excess of metal. Water in the form of steam plays an important part in this reaction, decomposing the carbides and liberating hydrocarbons. The supporters of this theory believe that the interior of the earth contains metals heated to enormously high temperatures. Water containing carbonic acid comes in contact with this incandescent mass, is decomposed and the resulting gaseous products contain petroleum. This petroleum finds its way to cooler strata and is there condensed. The reseaches of Moissan show that different carbides yield different hydrocarbons and it

is perfectly possible to imagine conditions that would produce petroleum of any desired composition. This theory is supported chiefly by the French and Russian chemists. We have not the space to enter into the various arguments advanced in support of their view and can only say that it explains many of the observed facts, but not all.

The supporters of the organic origin of petroleum are very numerous. Some believe that petroleum is formed by intense heating of deeply buried vegetable matter analogous to coal, or lignite, and a subsequent distillation into superincumbent strata. Others, that it is due to a slow decay of minute vegetable forms in limestones at a very moderate heat. Others that it is the result of decay under water, of vegetable matter, analogous to the action now going on in marshes. Others, that shales or limestones containing animal remains, have been subjected to heat, and the petroleum distilled off, to condense in other strata. Others maintain that it is the remains of large sea animals that have accumulated for ages, become covered with deposits and afterwards heated, whereby petroleum is distilled off. All these theories have certain observed facts to support them and many have been strengthened by experimental evidence. For example, Engler, a German chemist, distilled about a thousand pounds of fish oil in a closed retort, under a pressure of four to ten atmospheres, and obtained about sixty pounds of a distillate which contained many of the natural constituents of natural petroleum and could be fractionated into a kerosene that could not be distinguished from the natural product. Many other similar experiments have been made, but usually not with such satisfactory results.

The weight of evidence seems to be in favor of an organic origin for the petroleums and that the different petroleums are formed under different conditions and from different sources. Oils occur in formations of all ages, from Silurian to Miocene. As a rule the oil from the oldest rocks is simplest in composition, while those from newer formations are more complex and contain nitrogen and sulphur, the characteristic elements of animals. In other words, in early geographical times when plant life alone existed, the organic matter accumulated in plant forms and was decomposed and petroleum of the Pennsylvania type resulted. In later periods, when animal life made its appearance, similar decomposition went on and a petroleum was formed, but of different composition. This is apparently the case in California. These plant and animal organisms were minute and probably lived in water. The accumulations of their bodies on the bottom of the seas became covered with clays and sands and were buried for ages, and it is from these organisms that the petroleum resulted. The oils in many cases were subjected to secondary distillation, and gases, light oils, and heavy residuums resulted. The question is one of the greatest interest, but we have not the time to develop it fully, but I believe that in California we have a most promising field for determining the origin of its petroleum. We have made some experiments on this line in our laboratory. We distilled some shale that contained not a trace of petroleum and obtained about 25 per cent. of an oil that appears to resemble petroleum. The shale was filled with the remains of small shell fish, and it was from these that the oil was formed. We shall continue these experiments and hope to obtain some conclusive results.

In regard to its distribution, we find that oil exists in every part of California, and in fact it occurs along the whole coast from South America to Alaska. In California it seems to be chiefly confined to the Coast Range and the adjacent valley land. It occurs in very modern formations and is probably of recent origin. It is accumulated in masses of greater or less extent just as water is. These masses may vary from traces up to the enormous deposits we find in the Kern River country. Like all liquids it obeys the laws of hydrostatics and will follow the course of an impervious stratum frequently for long distances, accumulating under pressure at the tops of these domes or anticlines if confined by an impervious cap. When this cap is pierced the oil will frequently issue forth with considerable force due either to the pressure of superincumbent liquids or gas.

The proper location of a well is often a question of great importance, and the geologist needs all his skill in many cases to advise correctly. If oil and water occur together the oil by its lighter gravity will always occupy the upper portion, and frequently after the oil is drawn off, the well may yield water For the same reason water if admitted to a well may force the oil to some distant locality rendering the adjacent wells dry. The wisdom of the last legislature in passing a law intended to remedy this evil is apparent. The oil is probably not formed at the place where it is found, but has been transported by gravity, or with water, perhaps for very long distances. In this process of transportation it may be filtered or possibly distilled and lighter constituents separated from the heavier ones. When the oil issues into the free air the lighter constituents are evaporated spontaneously leaving a residue of more or less thick asphaltum.

It would not be within the province of this paper to dwell on the methods of exploitation of oil. They are probably familiar to all. As a rule the Eastern methods are employed with certain modifications made necessary by local conditions. The hydraulic rotatory system so much employed in Texas has lately come into use.

From the chemist's standpoint the properties of oil are of the greatest interest. Petroleum is not a homogenous body, but is made up of a large number of substances; some gaseous, some liquid and some solid. Part of these constituents are dissolved in the others and part of them remain in suspension. The contained bodies are very numerous, amounting probably to several hundreds or perhaps thousands. Some of these constituents are present in large quantities and some are present in barely more than traces. To separate these various constituents and obtain them in a state of purity is a problem of great difficulty. As yet very little has been done in regard to

attacking this problem, but the field is a most promising one, a number of people are working it, and before long we will have results that will throw more light on the problem of California petroleum.

Until the discovery of oil in California the two great sources were the Eastern field and the Russian field. Eastern oils are a mixture of paraffins, a term by which chemists designate a class of bodies differing widely in their physical characteristics, but chemically they are very much the same. The chief characteristic of these paraffins is their indifference toward chemical reagents. They are very stable and combine with scarcely any substances and stand a high degree of heat without much decomposition. Russian oils are made up to a large extent of so-called naphthenes, which differ from the paraffins by having a larger carbon percentage, a higher specific gravity, higher viscosity, but lower boiling point.

The result of this is that they cannot be burned in a lamp constructed to burn Eastern oil. The high viscosity and specific gravity do not allow it to rise up in the wick as rapidly, and a large flame cannot be well produced. Second, it gives off vapor at a lower temperature, and this vapor mixed with air explodes with considerable degree of violence. Third, the relatively high per cent. of carbon causes the lamp to smoke and frequently gives off disagreeable odors. These naphthene oils may be burned in properly constructed lamps, but such a lamp would not be well fitted for the burning of paraffin oils.

The California oils stand between the Eastern oils and the Russian oil. They contain paraffins as do the Eastern oils, but in much smaller amounts. By proper distillation 75 per cent. or more of good illuminating oil may be produced from good Eastern petroleum. California oil under similar circumstances will not yield much more than 15 per cent. This small amount, however, if properly refined will yield as good oil as that obtained from Eastern refineries, but if brought to this standard comparatively small amount is produced. California oils also differ from Eastern oils by the amount of asphaltum which is present. This seems to be present in practically every variety of California petroleum. When it does not contain it, it is probably due to a previous distillation or filtration whereby the oil is naturally freed from the heavy, non-volatile constituents. The oils of Santa Clara, Lake and Mendocino Counties seem to contain much smaller quantities of asphaltum than oils of the lower country, but they do not occur very abundantly.

In addition to paraffins and naphthenes California oils contain quite a quantity of what are known as Alkyl-benzenes, particularly of the higher boiling ones such as Xylene. It occurs in all three forms, the ortho, meta, and para. Some of these benzene derivatives are of great value, and in time much oil will be distilled and otherwise treated for the sake of these valuable benzenes. They can be made up into valuable chemical products, and I look for the time when factories will consume large quantities of these bodies and a new source of profit will open for the petroleum miner. Certain sulphur and nitrogen bodies occur in the oil that may also be used for the preparation of valuable materials.

We said that there are very many constituents in the oil and some of them will find use. As yet practically nothing is done in this direction. The rough separation of the oil into benzenes, illuminants, lubricants and asphaltum is made, but no attempts have been made to obtain any of these bodies in a state of purity. These distillates are almost as complicated as the original oil. This complex composition of California oils easily explains the variation in the properties of the oils from different regions and differences in behavior when they are treated. By various methods some of these constituents are separated out leaving a residue that is very different in composition from the original substance, and difference in composition will go hand in hand with difference in properties. For example, gravity, flash and burning points, viscosity, refractive index, etc. As these qualities are of considerable practical significance it might be of some use to dwell a little upon them.

By gravity is meant the ratio of the weight of a certain bulk of oil compared with the weight of an equal bulk of water. As oil is always lighter than water, the gravity will always be expressed in a decimal less than one. Usually, gravity is expressed in degrees Baume. This is an empirical scale coustructed by Baume, in which two instruments, one for liquids heavier than water, and one for liquids lighter than water, are used. He took the one for liquids heavier than water and placed it in a mixture of eighty-five parts water and fifteen parts salt and marked this point 15 degrees, and then continued this division until he reached 100 degrees. To construct a hydrometer for liquids lighter than water he placed his instrument in a solution of ninety parts water and ten parts salt and called this zero. He then put it in pure water and marked this point 10 degrees, and continued this system of division until he reached 100 degrees. This double system of marking gives rise to confusion inasmuch as the same degree may mean a liquid heavier than water or one lighter than water. But, as oil is always lighter than water there is little danger of confusion. The Baume degrees can be converted into specific gravity by the following formula:

Baume hydrometer at 15 degrees Centigrade $= \frac{144.78}{134.78+N}$ = specific gravity, where N represents the degrees indicated upon the spindle. As oil expands greatly upon heating the gravity will correspondingly vary, becoming lighter as the oil becomes warmer. As there are so many constituents in the oil this expansion is not absolutely regular, and will vary for oils of different gravity. The following table gives the change in gravity of a typical light and heavy California oil for a variation of about 20 degrees Centigrade. It is seen that there is a rise of about 1 degree Baume for an increase in temperature of 17 to 18 degrees Fahrenheit.

SPECIFIC GRAVITY OF CALIFORNIA CRUDE PETROLEUM.
(CORRECTED FOR TEMPERATURE.)

Temperature Fahrenheit Degrees	Gravity Degrees Baume Light Oil	Gravity Degrees Baume Heavy Oil
59	20.90	16.27
60	20.96	16 31
61	21.03	16.36
62	21.09	16.42
63	21.13	16.48
64	21.20	16.53
65	21.29	16.58
66	21.32	16.63
67	21.37	16.69
68	21.45	16.75
69	21.49	16.81
70	21.54	16.87
71	21.61	16.93
72	21.67	16.98
73	21.70	17.05
74	21 73	17.11
75	21.80	17.17
76	21.94	17.21
77	22.01	17.26
78	22.07	17 31

More marked even than the change in gravity under the influence of temperature is the change in viscosity. By viscosity is meant the comparative ease with which the molecules of oil move among themselves, and is usually measured by noting the length of time it takes for a definite volume of oil to flow through an orifice of definite size. Such an instrument is called a viscosimeter, or viscometer. If we measure the length of time for an equal volume of water to flow through this same orifice and divide the time of the oil by the time of the water, we will obtain what is known as specific viscosity. Of course, both determinations should be made at the same temperature. This is usually taken at 15½ degrees Centigrade, equal to about 60 degrees Fahrenheit. The viscosity of oil varies greatly according to the temperature, becoming very much less as the temperature rises, as shown by the following table:

SPECIFIC VISCOSITIES OF CRUDE OILS AT 60 DEGREES FAHRENHEIT AND 185 DEGREES FAHRENHEIT.

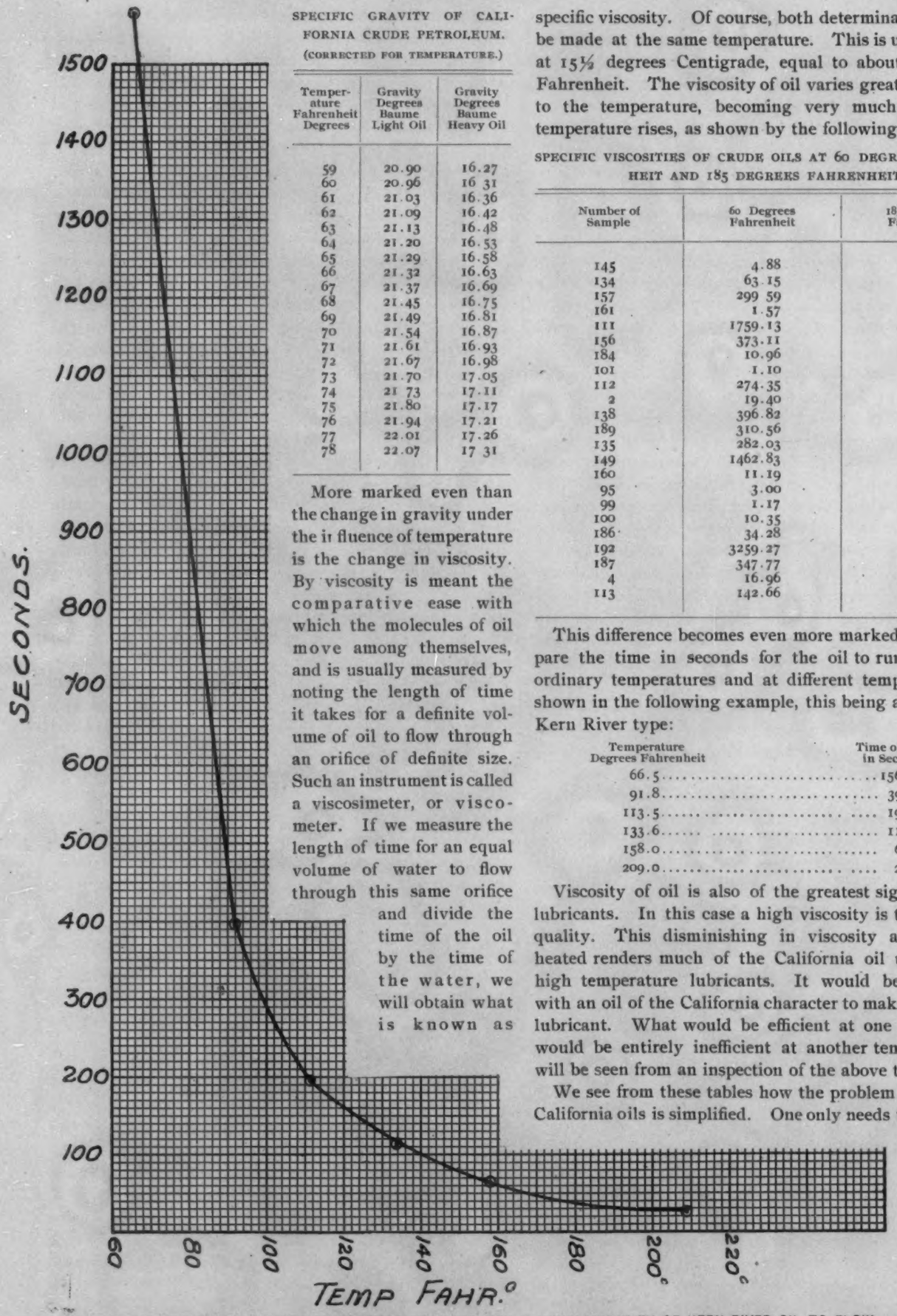
Number of Sample	60 Degrees Fahrenheit	185 Degrees Fahrenheit
145	4.88	1.28
134	63.15	2.12
157	299 59	4.70
161	1.57	1.05
111	1759.13	7.51
156	373.11	3.67
184	10.96	1.50
101	1.10	0.95
112	274.35	3.35
2	19.40	1.60
138	396.82	4.28
189	310.56	3.38
135	282.03	3 57
149	1462.83	8.35
160	11.19	1.54
95	3.00	1.15
99	1.17	0.96
100	10.35	1.34
186	34.28	1.84
192	3259.27	9.00
187	347.77	3.37
4	16.96	1.53
113	142.66	2.85

This difference becomes even more marked if we compare the time in seconds for the oil to run through at ordinary temperatures and at different temperatures, as shown in the following example, this being an oil of the Kern River type:

Temperature Degrees Fahrenheit	Time of Flow in Seconds
66.5	1565
91.8	397
113.5	194
133.6	114
158.0	66
209.0	25

Viscosity of oil is also of the greatest significance for lubricants. In this case a high viscosity is the desirable quality. This disminishing in viscosity as the oil is heated renders much of the California oil unsuited for high temperature lubricants. It would be impossible with an oil of the California character to make a universal lubricant. What would be efficient at one temperature would be entirely inefficient at another temperature, as will be seen from an inspection of the above tables.

We see from these tables how the problem of pumping California oils is simplified. One only needs to heat them and their viscosity diminishes enormously, and they may be pumped as easily,



CURVE SHOWING THE NUMBER OF SECONDS REQUIRED FOR A GIVEN QUANTITY OF KERN RIVER OIL TO FLOW THROUGH THE SAME ORIFICE AT DIFFERENT TEMPERATURES

or more easily, than water. The oil flowing through the long pipe line of the Standard Oil Company from Bakersfield to Point Richmond will be heated, and there is no doubt that pumping will be perfectly satisfactory. Heating stations on this line are about twenty-seven miles apart, and the pipe is covered with asbestos and waterproof material to prevent the chilling of the oil during its long journey.

Another point of interest to the oil chemist is the volatility. This is measured by the so-called flash point, or burning point, apparatus. As we have said, oil is a liquid of varied composition, containing constituents of all degrees of volatility from gas to solid. If such an oil be heated, the more of the lighter boiling constituents contained therein, the greater the amount of vapor produced. If the vapor is present in sufficient quantity to produce an explosive mixture with air, this mixture will ignite when brought in contact with a flame. If sufficient volatile matter be given off the flame will be continuous, or, in other words, the oil will burn. That is, if the oil be heated and it contains but small quantities of comparatively low boiling constituents, at a certain point it will ignite, but the flame will be almost instantly extinguished as the mass of the oil is not heated to the vaporizing point. If the heating be continued it will reach a point where the burning will be continuous. Vapor will be given off and it will ignite, and this will continue to burn until the oil is all consumed.

As a rule the higher the flash point and burning point the safer the oil, although it is perfectly possible that an oil may have a comparatively low flashing point and yet not take fire even if a light be brought in contact with it, if the burning point be sufficiently high. The greater danger of the low flash point oils is the formation of large quantities of gas in the closed tanks, which if ignited will cause a violent explosion. The remedy for such cases is to keep the tank full, or if that be not possible, by a system of ventilation to get rid of the volatile gases as fast as formed. Ventilation may, however, at times cause more harm than good. For an explosion to take place it is necessary to have gas and air mixed in proper proportions. As we recede from these proportions toward pure air or pure gas no explosion will take place. The danger is in the mixture. There is greater safety to be attained in the proper storage and handling of the oil than by making the measure of safety simply a flashing or burning point test. Not that these are not of value and significance, but reliance on such a test alone is insufficient. It would be practically impossible to make a set of regulations which would be the best under all circumstances. The conditions on board a veesel or in a building in the thickly settled part of the city and a factory in the country are so different that laws which would be best adapted for one set of conditions would be insufficient or unjust in the other. Each case should be rated by itself.

When we come to the uses of oil we find that as yet they are very limited as far as numbers are concerned. Fuel and illumination consume at present nearly the entire supply. A small quantity is used for lubricants, and a still smaller quantity for solvents, and the rest of the consumption is insignificant. Some time or other there will be uses found for many of the constituents. For chemical technology California oil is the storehouse of raw material that can be manufactured into finished products of more value than use as fuel. Too late, perhaps, it will be found that we have wasted our heritage.

It will be even worse than in case of the forests, for although they may be used up, in the course of a hundred years or so they may be re-established, but the production of oil probably has taken centuries, and the conditions may not be reproduced. The supply seems to be large as yet, and possibly the knowledge of its composition may be obtained before it is all exhausted. The sooner this is done, the better for the prosperity of California and of America.

The Application of Crude Oil to Gas Engines.

BY FRANK H. BATES.

THERE appeared in the current issue of a steam engineering magazine an offer by a certain company guaranteeing the production of power on a remarkably low basis of costs as compared with the best steam plants.

It takes one back to the days of George H. Corliss, who, after meeting with success in the construction of an engine essentially different from any preceeding it, and from which he developed remarkable economy, put into operation his peculiar business tactics, and, by guaranteeing to effect a stipulated saving, succeeded in introducing his type of engine, in a remarkably brief period of time, into every part of the world.

Reviewing briefly the progress of steam engineering since 1849, no radical changes are noted, rather the successive steps have each more forcibly pointed towards approaching limitations. From low pressure to high pressure steam, aided by jet and surface condensing; better furnace design; more efficient boilers; the introduction of superheaters, of the types directly attached and separately fired; the gradual perfection of economizers, providing for a better utilization of the heat energy of the escaping gases; improvements in feedwater heaters, of both the open and closed types; the introduction of induced and forced draft, under favorable conditions; the use of reheating receivers; of the intelligent use of jacketing; the better design of steam plants as a whole, cutting down the losses between the several units making up the entire equipment; finally, the changes in types of engines, bringing us to the Poppet valve Corliss type, the Westinghouse-Parsons turbine, the Curtis turbine and the De Laval turbine, all radically different. Today we are brought down to the following possible economies:

With the boiler plant, inclusive of economizer 80 per cent. thermal efficiency, taking the best record of steam engine performance, approximately 23 per cent., we have

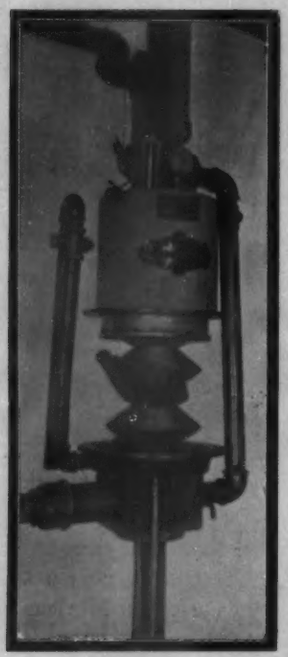


FIGURE 1
CATON CRUDE OIL RETORT

a combined efficiency of 80×.23=18.40 per cent., an efficiency only to be realized in connection with large units of the most refined types. Referring again to the internal combustion motor it might be said that thermal efficiencies as high as 38 per cent. have been claimed; it may be readily surmised then, that anyone knowing how closely steam plant economies have reached their confines, will naturally turn in this direction for any decided advancement.

This brings us to the purpose of the present writing, namely, a study of the methods of gasification of *crude oil* for the gas engine, a fuel the use of which has, within the past two years, introduced as remarkable changes in the way of fuel costs with all types of internal combustion motors as it has in steam practice.

Quoting Senator W. C. Ralston, ex-President California State Miners' Association:

I recently visited the Vandalia Mine, El Dorado Co. Cal. I found that with a seventy-five horsepower engine they were using Coalinga oil, distilling the oil and using the gas to run a gas engine, and their cost for the last five months has been from 17 cents to 20 cents an hour for seventy-five horsepower. That is $1.80 a month per horsepower. Free water power cannot beat that. I thought our power at Melones Mine, Calaveras County, was pretty cheap. We have the Stanislaus River and it costs us nothing but the maintenance of the flume; but, taking the cost of the dam, the cost of the flume, the cost of maintenance and charge off to depreciation, and we cannot provide power for $1.80 per month.

The Best Retort. Daniel Best was possibly the pioneer in introducing the use of crude oil with the gas engine by a method which has since become almost universal—the preparation of an oil vapor in a device separate and distinct from the engine proper, and by means of the waste gas exhausted from the engine.

This device consists of a cast-iron retort, having an inner pipe provided with deflectors, through which the exhaust gases pass, heating in their passage the oil gravitating over the outer cone-like surfaces of the pipe, said surfaces being provided with oil-retaining grooves. The whole is encased, said casing serving to confine the vapors rising from the heated oil. The engine, during the suction stroke, draws through the vapor chamber of the retort a quantity of air, which picks up, as it were, the oil vapor. The retort is operated at about 200 degrees Fahrenheit (the temperature being measured in the vapor chamber), and with a gravity oil feed.

Tassell's Retort is but a modification of the Best, and is manufactured by Tassell & Tassell, one of whom was formerly with The Best Manufacturing Company.

Caton's Retort is an improved form of a generator brought out by J. Trullinger, of San Jose, Cal. This retort, in its improved form, consists, as shown in the accompanying illustration (Figure 1), of a series of cones, connected below to a cast-iron fire-box, into which the exhaust pipe from the engine enters, and above to the exhaust to the roof. A casing, arranged to telescope, is shown raised to the upper half to permit of cleaning the outer surfaces of the cones. Piping is arranged in the form of a goose-neck and provided with a plug cock to admit the air, used as a carrier of the vapor, to the engine. On the right is shown a by-pass for the exhaust, permitting of regulation of the retort temperature. The retort shown was installed by the writer in connection with an engine of the throttling type, and used for driving a line of pumps, the equipment of a city water works. The funnel-shaped attachment resting on the first cone was so placed as to cause the oil dripping from the edge of the cone above to lead to the first channel of the lower cone, to better utilize the vaporizing surface.

Among the several troubles consequent upon the employment of such types of retorts as have been referred to, is the tendency of the vapor, which reaches the engine at a temperature of approximately 95 degrees Fahrenheit, to condense in the gas pipe, causing periodic floodings of the engine. This may be partly checked by carrying some of the exhaust gas around the gas or vapor pipe, thus avoiding the excessive condensation. The writer has made it a practice, in connection with the installation of retorts of this type, to thoroughly protect all vapor line by heat-retaining material, and to further provide a trap close to the engine throttle. This is shown in Figure 2 at the front of the engine.

Figure 3 is an outside view of the gas engine water

FIGURE 2. WESTINGHOUSE TWO-CYLINDER VERTICAL TYPE GAS ENGINE ARRANGED FOR THE USE OF CRUDE OIL

works installation. A watering cart may be noticed in front, which suggests the means adopted to furnish water for jacket circulation while swelling up the tank in the tower.

Another source of trouble, which proves very serious when continuous service is required, is the carbonization of the oil on the vaporizing surfaces, together with the gradual accumulation of asphaltum or residue. Provision is made for draining away the latter while in a liquid state, and this can be done while operating, but a stoppage is necessary to permit of the removal of the hard burnt carbon. Figure 4 illustrates very plainly the method of procedure. An examination of the cones of the retort under a magnifying glass discloses the heavy deposit of carbon, bearing more or less resemblance to stalactites. This formation greatly detracts from the efficiency of the heating surfaces, and proportionately impairs the economy. The cover, shown suspended by the chain tackle, is made easily removable, so that the cones, which rotate, are readily cleaned. This is the case at least in the smaller sizes, but the figure is illustrative of the largest retort of this type yet built, and, being necessary to clean at least twice weekly, it means a stoppage over a considerable period. The white asbestos-covered pipe above, with an offset, conducts the air charged with oil vapor to the engine.

Figure 5 shows a continuation of this pipe to the engine, and in the rear, the retort with cover on and protected with asbestos.

The following tabulated results of tests made by the Arizona and Southeastern Railroad Company, at Bisbee, A. T., very well illustrates the economy to be derived by the use of a retort, the first table giving an average speed of 226⅜ and a running time of three hours and twelve minutes, with 40 gravity distillate fed at the engine mixing valve, whereas the third, with the same quantity of the same fuel, gives the higher speed average of 227⅝ over the greater running time of four hours and nineteen minutes by use of the retort process.

FIGURE 3. WATER WORKS, TOWN OF WINTERS, CAL., EQUIPPED WITH A WESTINGHOUSE GAS ENGINE AND CATON CRUDE OIL RETORT

40 GRAVITY DISTILLATE.

Time	Speed Per Minute	Number Explosions Per Minute
8:00	232	68
8:30	227	82
9:00	228	101
9:22	220	76
10:00	224	94
10:30	228	87
11:00	226	..

Average speed, 226⅜. Running time. 3 hours, 12 minutes.

COALINGA CRUDE OIL FED THROUGH RETORT.

Time	Speed Per Minute	Number Explosions Per Minute
11:30	231	80
11:50	228	80
12:30	227	82
1:00	227	86
1:30	226	88
2:00	227	83
2:30	226	92
3:00	227	83
3:30	227	76
4:00	228	78

Average speed, 227⅜. Running time, 5 hours.

40 GRAVITY DISTILLATE THROUGH RETORT.

Time	Speed Per Minute	Number Explosions Per Minute
8:00	225	88
8:30	228	77
9:00	228	81
9:30	227	79
10:00	229	76
10:30	229	77
11:00	228	79

Average speed, 227⅛. Running time, 4 hours, 19 minutes.

FIGURE 4. A CRUDE OIL RETORT WITH VAPORIZING CONES EXPOSED TO VIEW SHOWING CARBON DEPOSITS

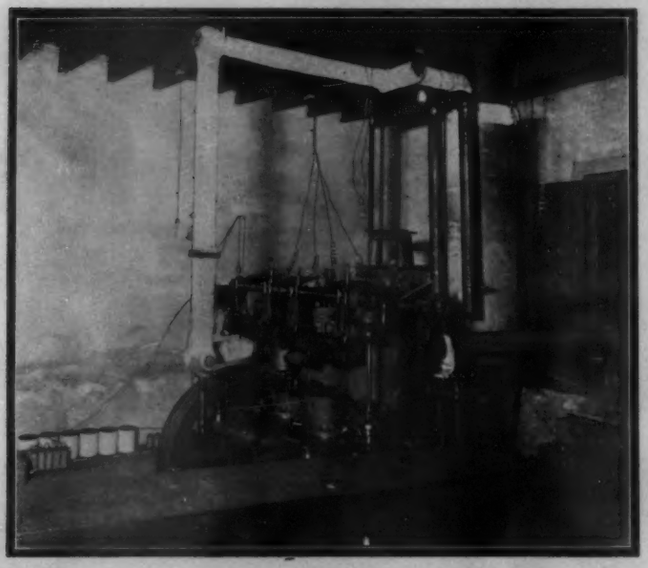


FIGURE 5. CRUDE OIL RETORT WITH COVER ON SHOWING CONNECTIONS TO A WESTINGHOUSE ENGINE

The Economist Retort. The design of this device (Figure 6) is rather different from those preceeding by reason of the use of a rotating drum, which serves to gradually propel the oil forward from rear to front, as by a conveyor action, at the same time avoiding, to a certain extent, the concentration of heat in a way to bring about excessive burning of carbon. Even this retort requires occasional cleaning, however.

Figure 7 is a layout of a gas engine crude oil plant, and, under a reading glass it will prove suggestive in the completeness of its detail. The piping above the retort is designed to provide for keeping the pump in constant operation, while by the by-pass arrangement only such oil as is necessary, by reason of load requirements, is fed.

The air starting equipment, consisting of air storage capacity and air pump, is shown at the lower end of the plan view.

Figures 8 and 9 show front and rear views of an experimental retort for crude oil being developed by the Westinghouse Machine Company at its shops at East Pittsburg. In April, 1902, the writer assisted in these tests, using crude oil from the Coalinga district.

The feed of oil was regulated by the tension of the oil vapor, and all condensed vapor was automatically returned to the oil tank. The vaporizer has been tested on—

1. Gasoline.
2. Mixture of gasoline and fuel oil.
3. Coalinga crude oil.

A maximum compression of 103 pounds per square inch was used.

The temperature of the exhaust gases leaving the retort was but 58 degrees Fahrenheit above the temperature of the retort itself.

Results as good as one brake horsepower per 0.0915 gallons Coalinga crude oil were obtained.

Chas. C. Moore, & Co.'s Crude Oil System for Gas Engines. When gas engines are to be used in connection with service having a low load factor, that is a a load varying between wide limits, as is the case in electric railway work, electric lighting in conjunction with power service, and in power plant work generally, or where continuous service is a requirement, as in reduction works, etc.; the use of the retorts so far described is not feasible, by reason of—

First. Tendency to carbonization of the oil on the vaporizing surfaces of the retorts, requiring shut-downs for cleaning.

Second. Frequent stoppage of the engines by flooding on a change of load.

Third. Impossibility to maintain close regulation at the engine.

The two first factors have been discussed; the third is due to the "hand to mouth" nature of the oil feed, and consequently of the vapor formation, not permitting of a sufficiently prompt response to the calls of the governor, at the times of load changes, remembering that these retorts are all operated under a partial vacuum, graduating the feed of oil in proportion to the load requirements. Further, the fact that the mixture of air and oil vapor, giving a maximum mean effective pressure, lies between a lean mixture and one which is rich in oil vapor, introduces a condition which at once bars out the partial vacuum type of retort, when close regulation at the engine is demanded.

Let us follow this through—running under a light load, as an increase comes on, the governor, if of the throttling type, rises, increasing the vacuum effect on the retort, or, if a mechanical oil feed, actuated by link work from the governor is provided, it is opened in proportion to the requirements; either give rise to the same result, namely an increased flow of oil into the retort and over its heating surface. This causes the quality of the vapor to change, becoming richer, and since the proportion of air at the retort cannot be automatically regulated to exactly neutralize the increased richness of the vapor, and further, since the proportion of air admitted at the engine remains a constant, except as it is changed by hand, necessarily the richness of the mixture of vapor and air passes the point giving rise to a maximum mean effective pressure, and thus the governor, struggling to meet the demand for more power, continues to open, again increasing the oil feed at the retort and finally drowning the engine with a mixture too rich to be combustible. The same results follow in connection with the "hit and miss" type of governing.

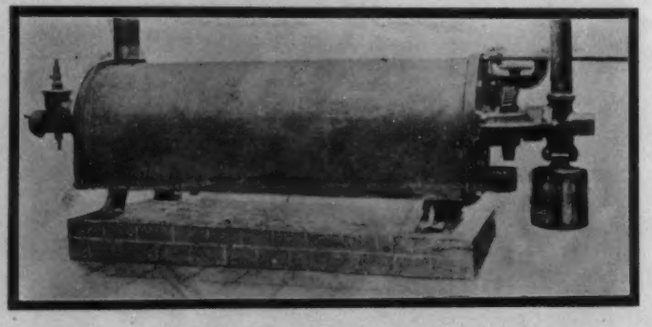


FIGURE 6. ECONOMIST CRUDE OIL RETORT

The indicator card (Figure 10) very clearly pictures the effect of a vapor too heavily charged with oil. It was taken from a two-cylinder Westinghouse engine of about eighty-five brake horsepower and used in electric lighting service. The engine had just received an addition to its load and the oil feed responding had formed too rich a mixture, making it almost impossible for the vapor to ignite without changing the proportion of air.

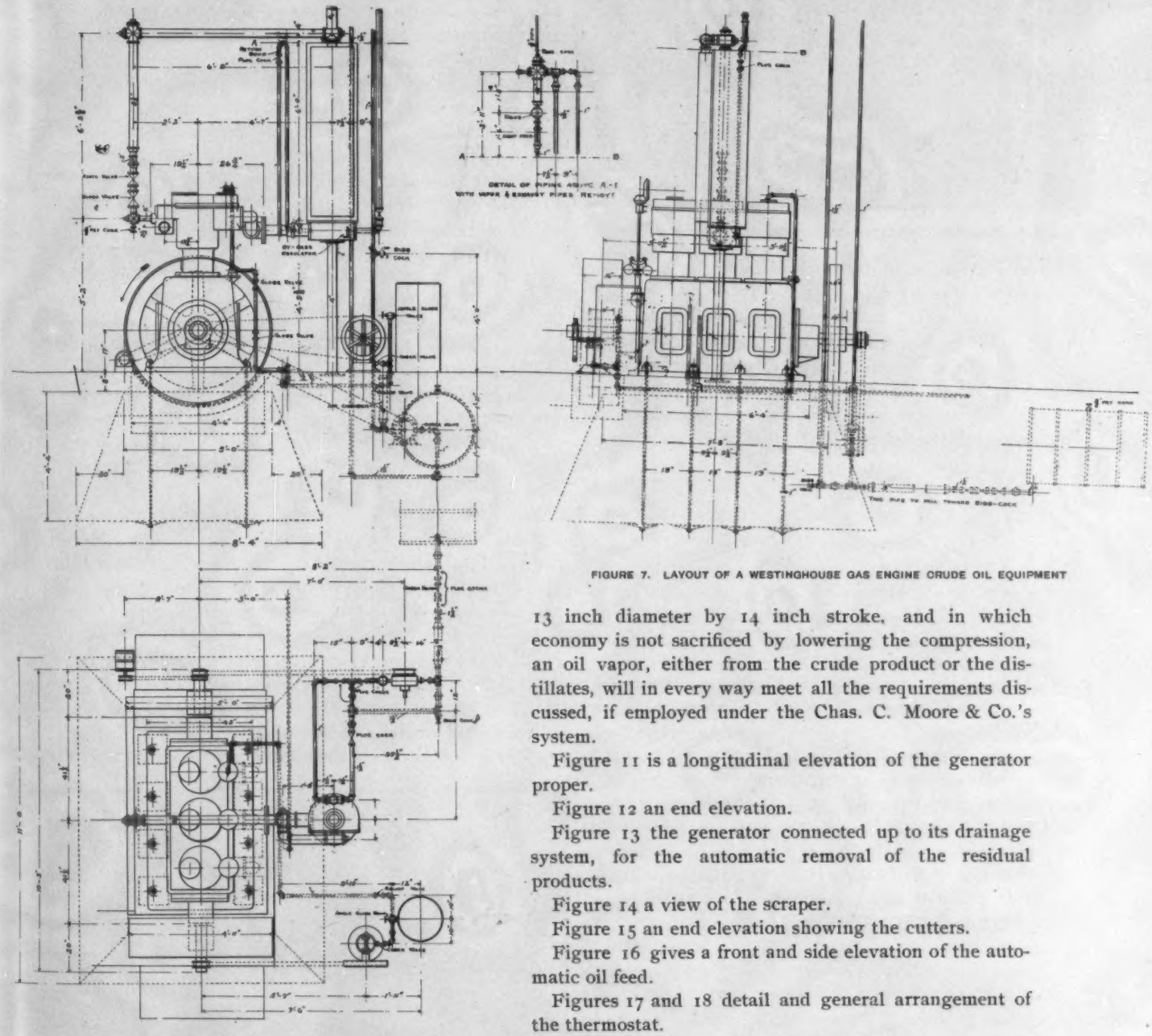


FIGURE 7. LAYOUT OF A WESTINGHOUSE GAS ENGINE CRUDE OIL EQUIPMENT

In an endeavor to adapt the Westinghouse engines to the use of crude oil, while maintaining their features of close regulation and positive service, the writer conducted, some three years back, a series of tests in an experimental Westinghouse gas engine plant, erected at Black Point, San Francisco. Use was made of crude oils, varying in degrees Baume from 35 to 12, and of distillates from 55 to 28. The marked economy resulting from these tests encouraged a continuation of the same at the Westinghouse shops at East Pittsburg, Pa. From this pioneer work on the Coast the two systems described below were gradually evolved.

The Chas. C. Moore & Co's Crude Oil System for Engines not exceeding cylinder dimensions 13 by 14 inches. In engines not exceeding cylinder dimensions of say 13 inch diameter by 14 inch stroke, and in which economy is not sacrificed by lowering the compression, an oil vapor, either from the crude product or the distillates, will in every way meet all the requirements discussed, if employed under the Chas. C. Moore & Co.'s system.

Figure 11 is a longitudinal elevation of the generator proper.

Figure 12 an end elevation.

Figure 13 the generator connected up to its drainage system, for the automatic removal of the residual products.

Figure 14 a view of the scraper.

Figure 15 an end elevation showing the cutters.

Figure 16 gives a front and side elevation of the automatic oil feed.

Figures 17 and 18 detail and general arrangement of the thermostat.

Figure 19 a detail of the thermostat valve.

Description. In this system the oil, instead of being passed over the vaporizing surface of the generator in a thin film, is maintained at a constant level, automatically, by the oil feeding device (Figure 16), and at a height about corresponding to midway at the lower end of the inclined vaporizing chamber (Figure 11).

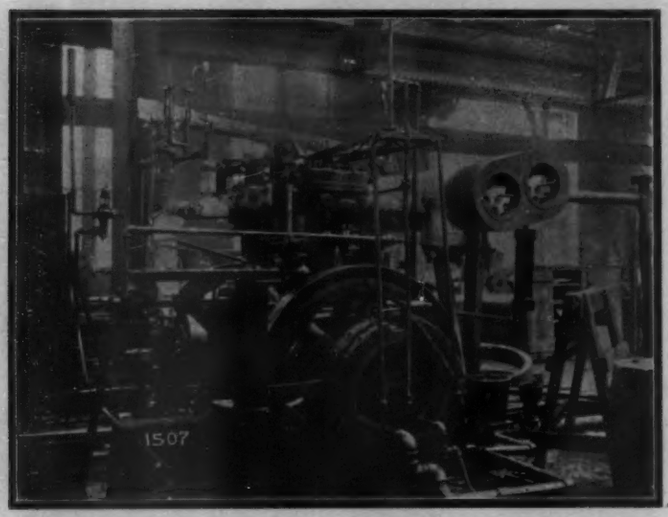


FIGURE 8. FRONT VIEW OF WESTINGHOUSE EXPERIMENTAL CRUDE OIL RETORT

Since a variation in the temperature of the vaporizing chamber, even as slight as 1½ per cent. of that indicated by the thermometer, will necessitate a readjustment of the air at the engine, it is held within very narrow limits by means of the thermostat and valve system shown in Figures 17 to 20.

For the removal of asphaltum and residual matter, the drainage system shown in Figure 13 is employed.

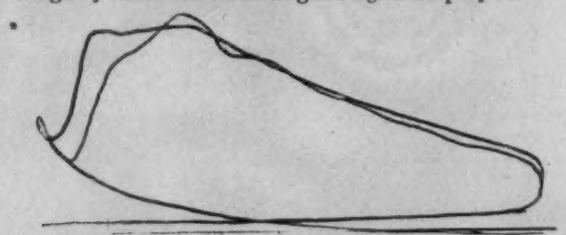


FIGURE 10. INDICATOR CARD SHOWING EFFECT OF TOO RICH A VAPOR

To prevent the accumulation of carbonaceous matter on the vaporizing surface, the scraper, shown in Figures 11 to 15, is rotated at intervals by hand.

Method of Operation. Oil is first fed into the vaporizing chamber (Figure 11) by way of the valve G^3, until the level in both this chamber and the oil feed device (Figure 16) is a little above the level of the upper drain pipe G^4. The oil feed device is connected above and below the center of the float by pipes directly connected to the vapor chamber of the generator and is so positioned as to maintain the oil at the level already referred to.

A refuse oil burner, of the Wilgus type, using air from the compressed air storage tank* and the oil residue drawn from the generator, is inserted in the exhaust gas passage of the latter, at a point marked piece *C*, shown in the detailed working drawing (Figure 20), and its flame, confined by the partition shown until it reaches the rear end of the generator, passes through ports into the top section of the casing or exhaust passage, and, through a nozzle, out by the exhaust pipe to the roof. The temperature of the vaporizing chamber is brought to 300 degrees Fahrenheit, indicated by a thermometer inserted in the vapor pipe, when the oil burner is uncoupled, the door, marked piece *C* (Figure 20), closed, and air, under a few ounces of pressure, held uniform by a pressure regulator, is introduced through the heated body of oil, by small pipes within G^1-G^4 (Figure 11).

The engine is started by compressed air, and in but a brief interval of time the air, heavily charged with oil vapor, is passed through nozzle G^2 (Figure 11) to the engine cylinders. The exhaust gases from the engine are now utilized in furnishing the heat first supplied by the oil burner, being passed through and by-passed around the generator to the exhaust pipe leading to the roof, automatically, by the thermostat device, according as the temperature of the vapor chamber rises or lowers with variation in load, and consequently in proportion to the varying number of British thermal units supplied by the exhaust from the engine.

The thermostat device consists of an aluminum tube (Figure 17) (aluminum because of its high co-efficient of expansion) inserted directly into the vapor chamber, in such manner as to permit of a circulation of the heated oil vapor throughout its length. The aluminum tube, closed at its upper end, is attached to a lever system, shown in greater detail in Figure 18, designed to increase the extent of movement per unit of heat, and which finally actuates the stems of the auxiliary valves of the main thermostat valves (Figure 17) through the bell-cranks shown.

The operation of the thermostat valves is as follows:

As the temperature of the vapor chamber rises above the point at which the valves are set to operate, the elongation of the aluminum tube forces the stem of the small needle valve, of the upper thermostat valve, just enough to bring it to its rear seat (see Figure 19), opening the top of the large valve to atmospheric pressure, while the other side, of larger area than its seat below, is subject to the terminal pressure of the exhaust from the engine, this pressure sufficing to lift the main valve, opening it to the passage outside the vapor-

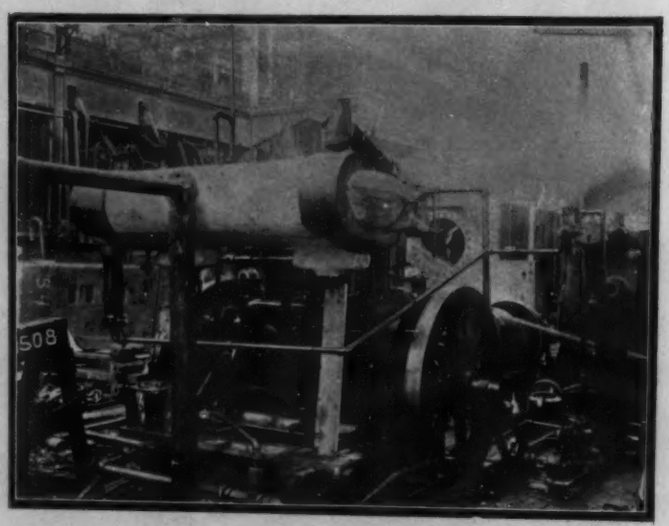


FIGURE 9. REAR VIEW OF WESTINGHOUSE EXPERIMENTAL CRUDE OIL RETORT

*An air starting device, consisting of air storage capacity and air pump is furnished with all Westinghouse gas engines.

izer, by-passing the exhaust gases until the temperature of the vaporizing chamber again becomes normal, when the stem of the needle valve seats it at the forward end by the movement resulting from the contraction of the aluminum tube. This closes the upper chamber of the thermostat valve to the atmosphere, while opening to the top of the large valve, the small passage from the exhaust pipe of the engine, thus overbalancing the pressure and quickly seating the valve. In the meantime the other valve, by reason of its inverted bell-crank, has successively closed and opened to the passage through the retort.

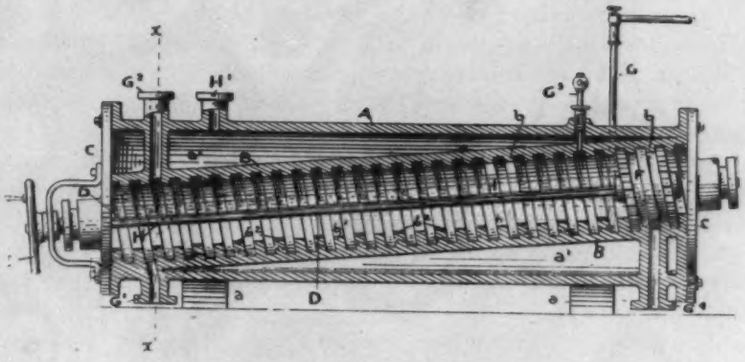


FIGURE 11. CRUDE OIL SYSTEM SHOWING LONGITUDINAL ELEVATION OF THE GENERATOR

It will be seen that this action is absolutely positive and confines the temperature to within a very small degree of variation.

An inspection of the seats of these valves discloses the provisions made for renewal, which is possible with but small cost of time or material.

As the oil is gradually distilled off it is replenished by the automatic oil feed (Figure 16), which consists of a ball float, connected by link work to the small valve

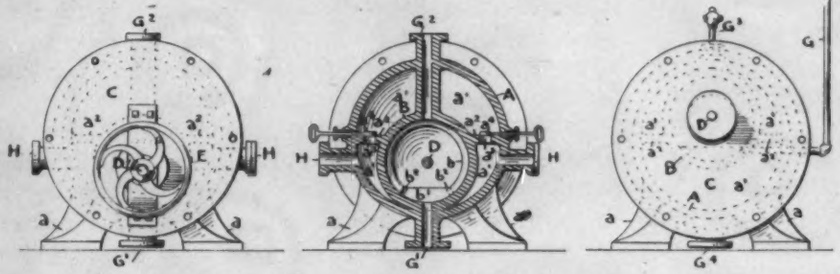


FIGURE 12. CRUDE OIL SYSTEM AND ELEVATION

shown, having a very narrow seat, thus avoiding any great inequality of area above and below.

Connected to the small chamber above the valve is a line of piping, constituting the force line from an oil pump, driven direct from the main engine and taking its oil from a large main oil storage tank without the plant. Just beyond the tee connection to the feed device is shown a pressure relief valve, beyond which the pipe continues back to the main oil storage tank. The operation of the feed device is as follows: With the pressure relief valve set at a pressure a trifle in excess of that in the vapor chamber, the oil is forced by the oil pump against the closed valve in the entrance chamber of the feed device, until the pressure rises sufficiently to open the relief, when it discharges back to the storage tank. As the level of oil in the vaporizing chamber of the generator lowers it does likewise in the feed device, causing the ball float to sink and in so doing to open the small valve, admitting more oil, which brings up the level in both the float and vaporizing chamber, gradually shutting the small valve. Of course this action resolves itself into a simple throttling of the oil in accordance with the load. As the device is almost perfectly balanced, the slightest change in level suffices to operate it.

In the generator, as the lighter or gas-making oils are distilled off, a residual product accumulates, by reason of difference in specific gravity, on the bottom of the vaporizing chamber.

To better facilitate the removal of this product and to prevent of its carbonization on the heating surface, the scraper (Figures 11, 14 and 15) is rotated and forced back and forth from end to end. A helical thread constituting the inner surface of the vaporizer, in combination with a rotatable shaft provided with a feather, which causes the scraper to revolve, affords a means of forcing it from end to end as the shaft is turned by a hand wheel from without. This is necessary about once an hour and in no way interrupts the operation of the plant.

The scraper is provided with perforations to permit of the vapor passing through it, whatever may be its position with reference to the vapor outlet nozzle. The residual products are drained through the nozzles G^1 and G^4 (Figure 11) to the pot J (Figure 13) while

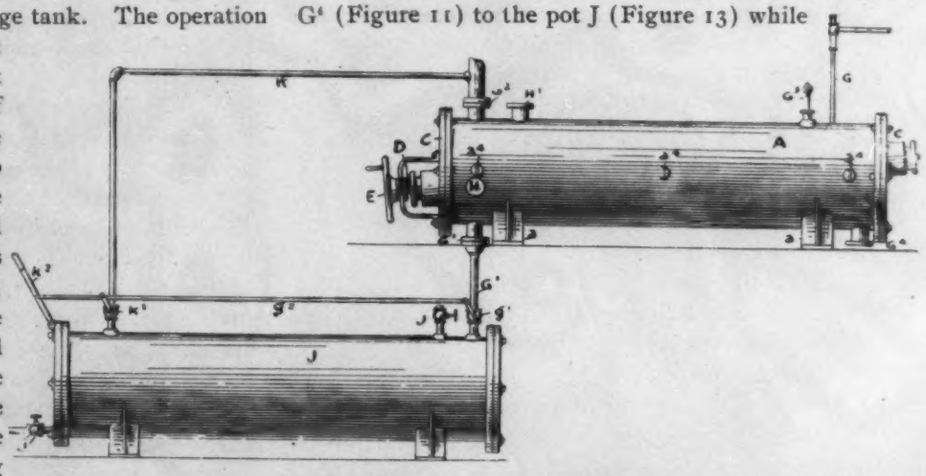


FIGURE 13. CRUDE OIL SYSTEM SHOWING THE GENERATOR CONNECTED UP TO ITS DRAINAGE SYSTEM FOR THE AUTOMATIC REMOVAL OF THE RESIDUUM

the latter is connected up, so as to afford an equilibrium of pressure with reference to both pot and vaporizing chamber. The pot is blown out by compressed air from time to time, (about once daily) while shut off from the generator.

A special system of piping absolutely prevents all tendency to flood the engine by accumulation of condensed vapor, and condensation on the cylinder walls, which would cause an accumulation of distillate within the crank chamber,* is avoided by pre-heating the air used at the engine.

Summing Up. This system provides a constant quality of oil vapor at the engine under a constant pressure, permitting of the engine regulation meeting the most severe requirements, under all conditions of load. The several functions are so intimately related, one to another, that the oil is fed and vaporized only in direct proportion to the load requirements. As all portions of the vaporizing

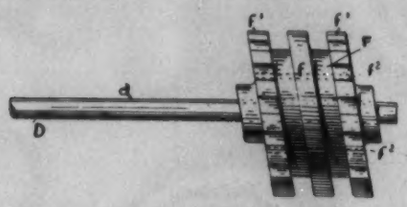


FIGURE 14. VIEW OF THE SCRAPER

FIGURE 15. ELEVATION SHOWING CUTTERS

system are protected by heat-retaining material and as there are no perceptible fluctuations in temperature conditions, highest economy is realized. Furthermore the automatic features, taken in conjunction with the provisions for cleaning while in operation, permit of continuous service being handled with success, under this system.

The Chas. C. Moore & Co's Crude Oil System for Engines Exceeding Cylinder Dimensions 13x14 inches.

This system is installed in plants of sufficient size to warrant the more extensive equipment and provides a fixed combination oil and water gas which may be piped for use with other engines located some distance from the point of gas production, though preferably close by.

Description. Figure 22 gives a plan, front-side and rear elevation of the system in which

A—Designates a three-cylinder Westinghouse vertical type gas engine.

B—Crude oil generator.

C—Superheater.

L—Air-heater.

J—Steam generator. (not shown)

K—Steam superheater.

D—Drainage pot for residual oil.

E—Air storage tanks.

F—Crude oil pump.

G—Engine circulating water pump.

H—Air compressor.

I—Automatic oil feed.

Generator *B* is generally similar to the generator already described in connection with the previous system, as is also the drainage pot *D*, automatic oil feed *I*, and thermostat device *M*, with valves No. 25 and No. 28.

A detail of the superheater, Figure 22, shows an inner chamber with a screw and scraper for clearing the vaporizing surface of carbon, and hand wheel outside for operating same, together with an outer casing to provide a combustion chamber for burning the residue by a compressed air system, the burning gas from burner traveling to the rear and beneath the superheating chamber, and then upward by the ports shown, and forward and out by the nozzle at the front end.

The air heater *L* consists of an enclosing casing around the exhaust pipe from the engine, arranged for preheating some of the air admitted to the engine cylinders.

The steam generator *J* (not shown) consists of a casing around the gas pipe leading to the engine cylinders, provided with stuffing boxes, and generally resembling the steam superheater *K*, a casing around the combined exhaust from generator and superheater. A portion of the circulating water from the engine jackets is automatically passed around the hot gas line 16, generating steam, while serving as well to reduce the temperature of the heated gas to a point which will permit of its use in the engine without giving rise to premature ignition on admixture with air.

The steam superheater further prepares the steam generated for admission to the generator.

Method of Operation. Starting with the oil line, the pump *F*, draws oil from the oil storage tank, preferably located a distance from the plant, to conform to the underwriters' requirements, and forces it to the automatic oil device *I*, where such quantity as is not required by the generator is passed by the relief valve 92, on by the overflow pipes 93 and 95, to the oil storage tank.

The oil passing into the feed device *I* is in turn passed out to the generator *B* by pipe 97, where it is largely vaporized at a temperature of not less than 300 degrees Fahrenheit, the residue passing to the drainage pot *D*, thence to a storage tank, to be later used for supplying the Wilgus burners at the generator and superheater.

The oil vapor in the vaporizing chamber of the generator *B* is met by superheated steam, derived from the circulating water passing out of the engine jackets at a temperature of about 140 degrees Fahrenheit by pipe 37, thence to a steam generator* located at about *J*, on the gas line 16 to engine, where the excess water above that required for gas making is automatically, by means of a pressure relief valve, passed to the cooling tower or water drainage system. The water in the steam generator *J*, reduces the temperature of the gas, and finally, as steam, passes by pipe 38 to the steam superheater *K*, thence by outlet 40 and pipes 41, 44, and 48, and risers 43 and 50, into the generator where it mingles with the oil vapor as stated. The mixture of oil vapor and superheated steam, at a temperature of not less than 300 degrees Farenheit, passes through the outlet nozzle at the generator by pipe 57, into the superheater *C*, where under a temperature of

*Westinghouse engines are provided with the crank case system of lubrication.

*The water, as shown in the general arrangement Figure 23, passes directly to the superheater, the steam generator being omitted.

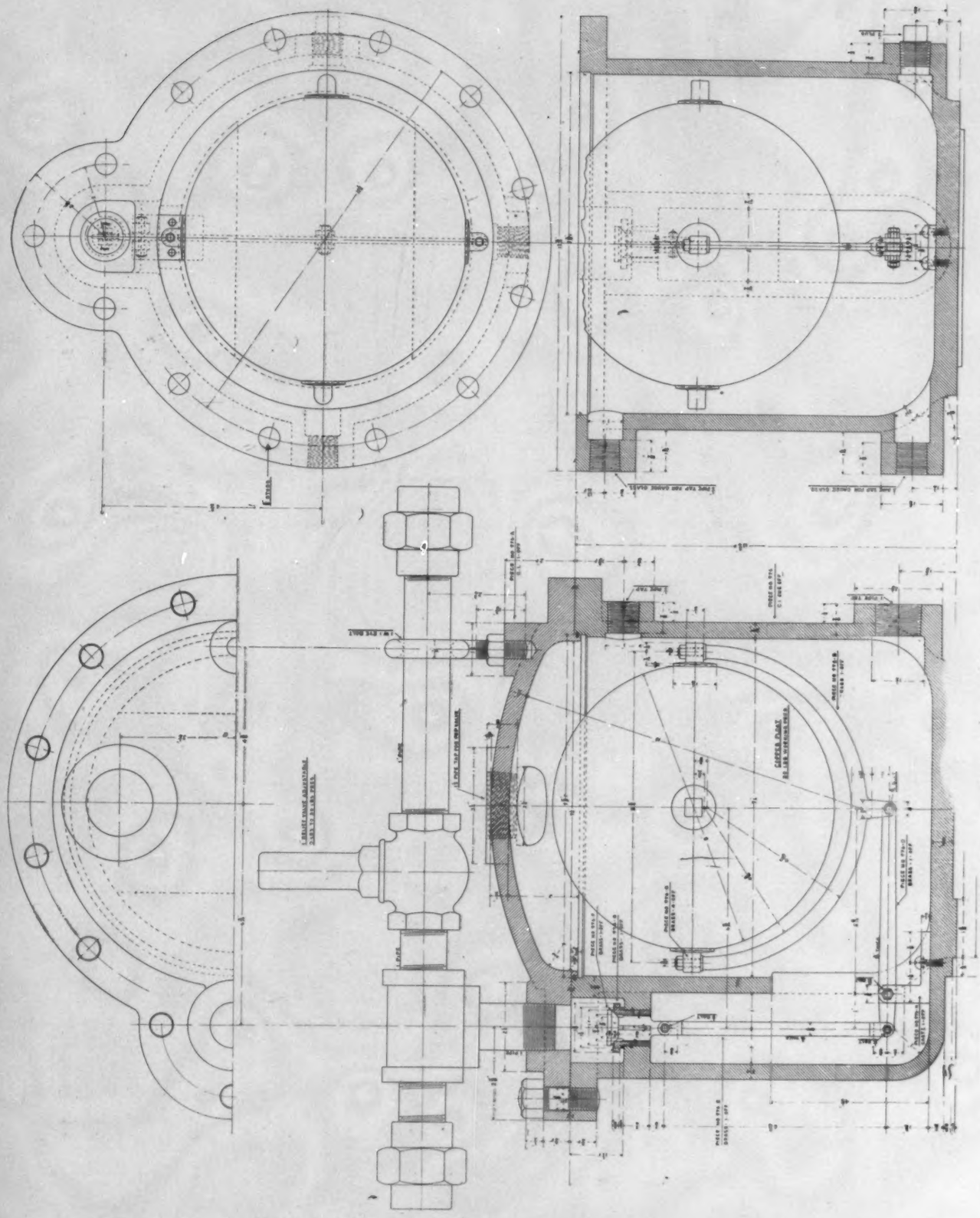


FIGURE 16. CRUDE OIL SYSTEM SHOWING AUTOMATIC OIL FEED

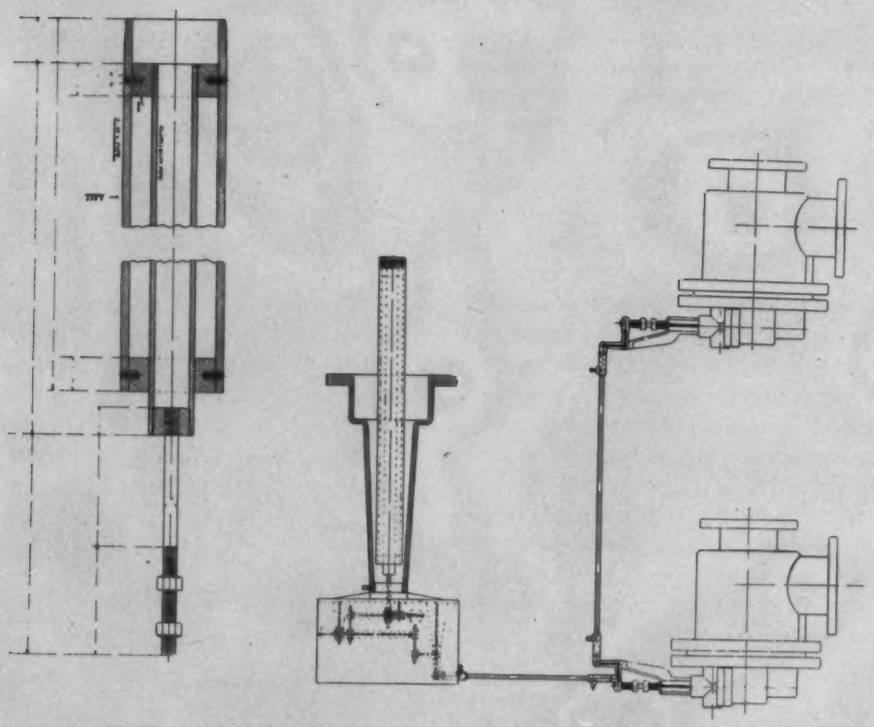


FIGURE 17. CRUDE OIL SYSTEM WITH DETAIL AND GENERAL ARRANGEMENT OF THERMOSTAT

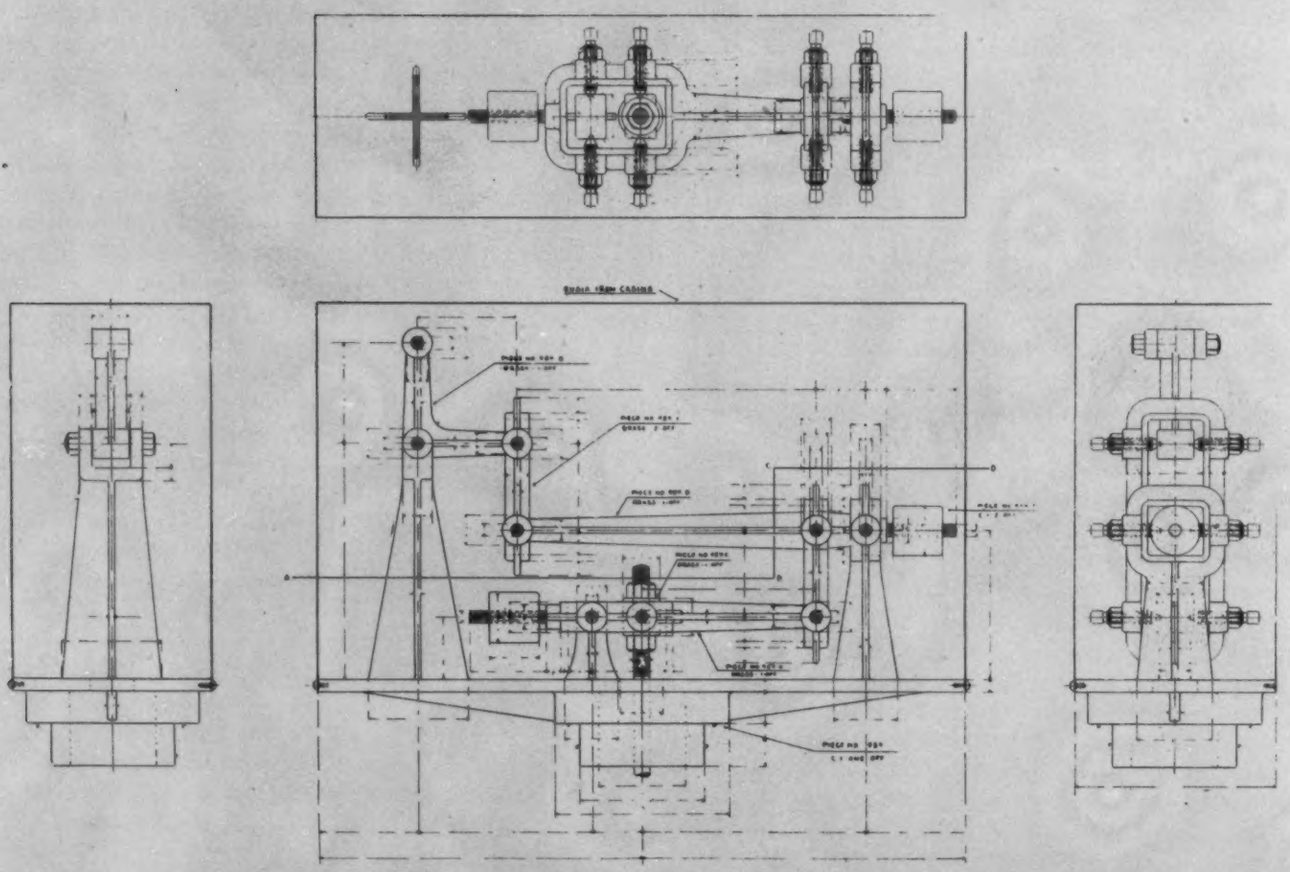


FIGURE 18. CRUDE OIL SYSTEM WITH DETAIL OF THERMOSTAT LEVER SYSTEM

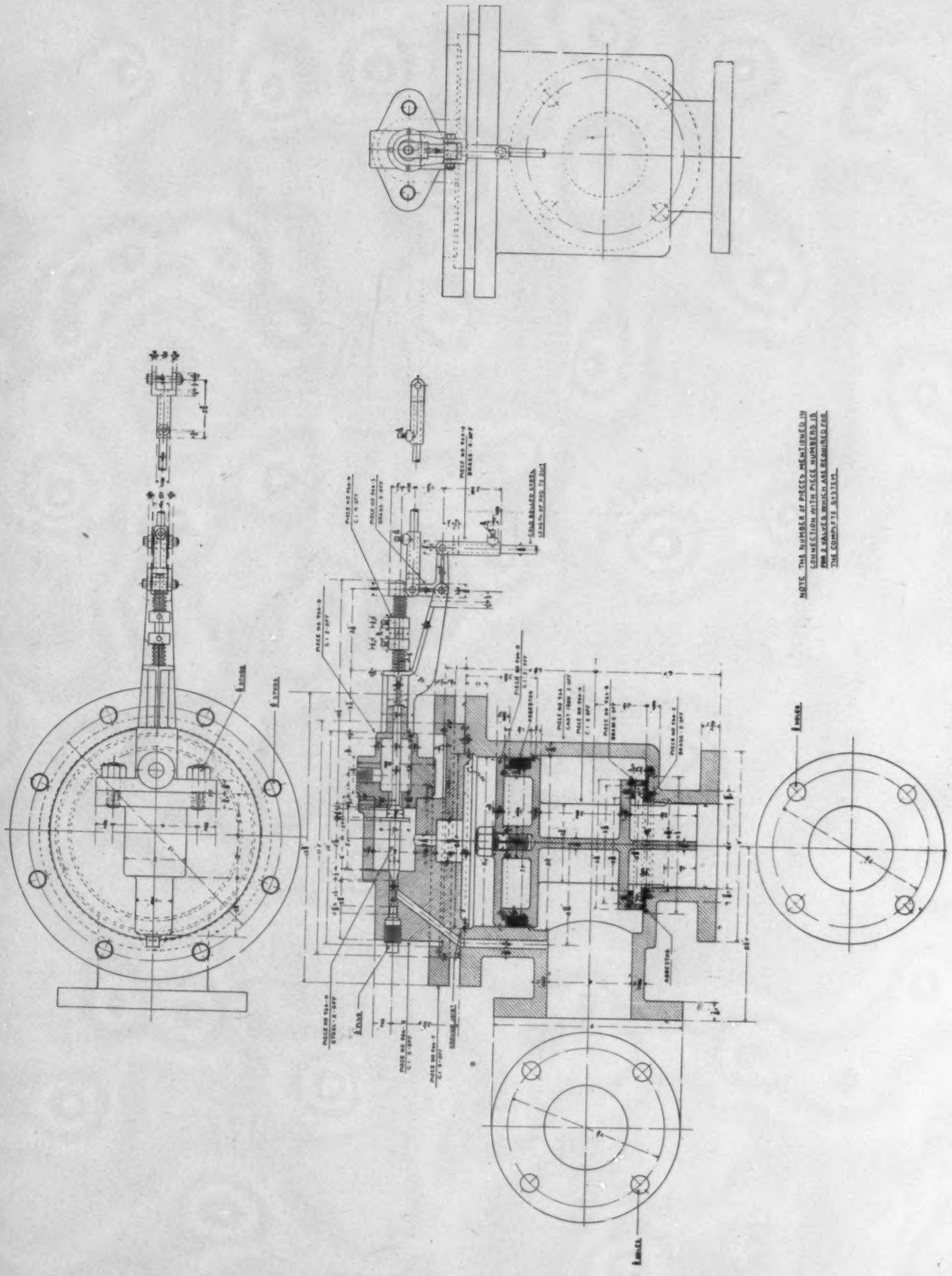


FIGURE 18. CRUDE OIL SYSTEM THERMOSTAT VALVE

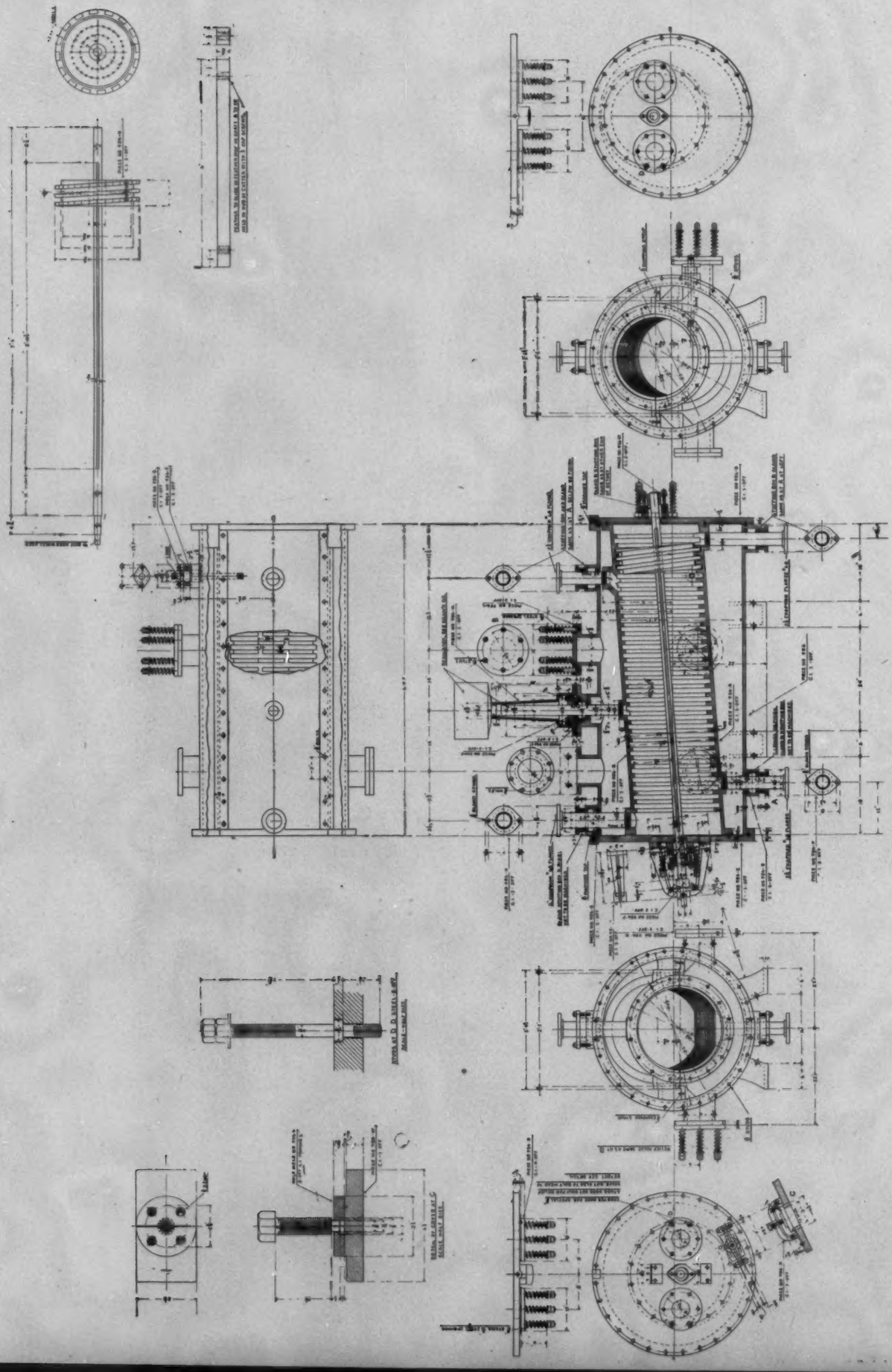


FIGURE 20. DETAILED DRAWING OF CRUDE OIL SYSTEM

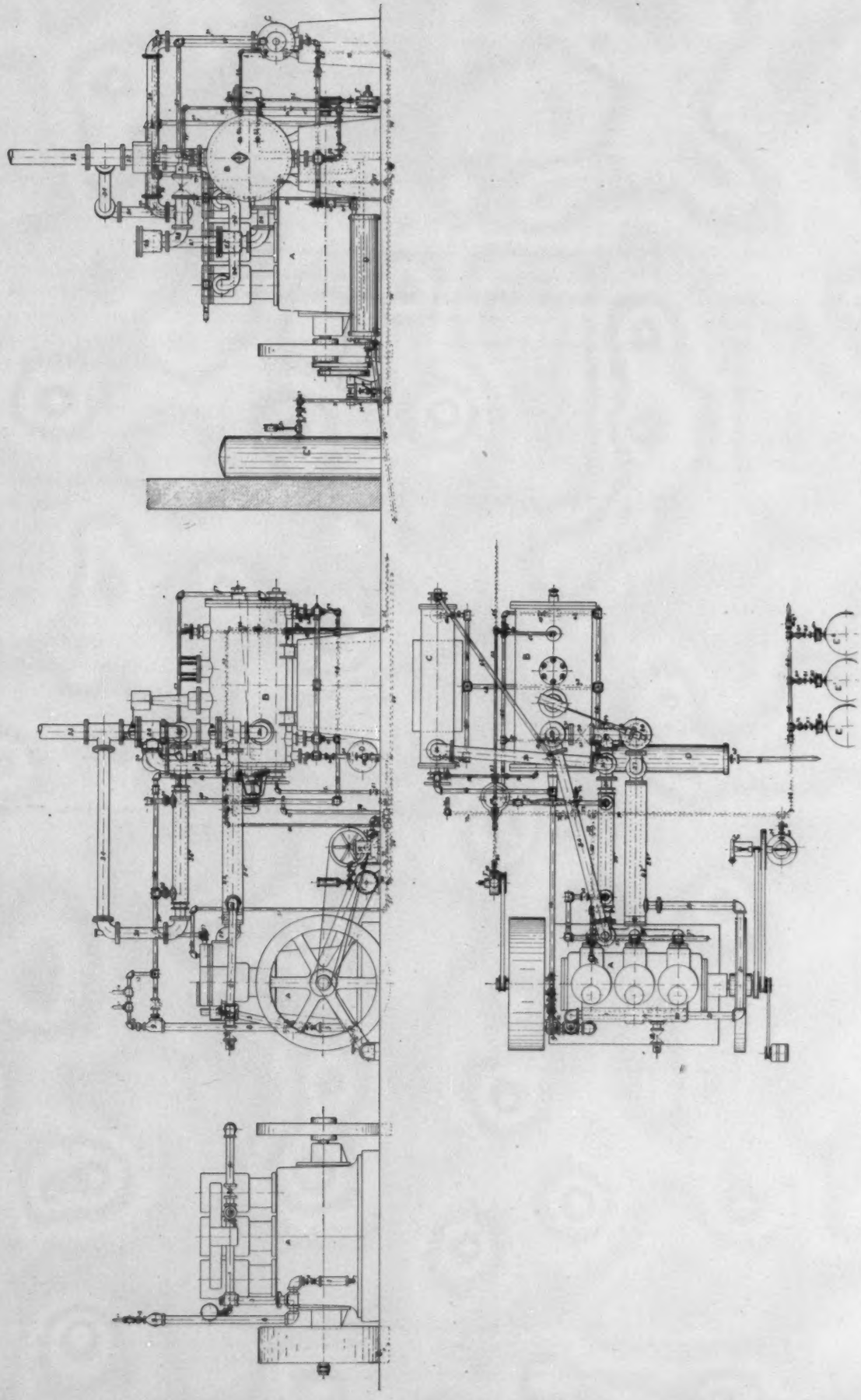


FIGURE 21. GENERAL ARRANGEMENT OF SYSTEM FOR ENGINES HAVING CYLINDER DIMENSIONS LARGER THAN 13 BY 14 INCHES

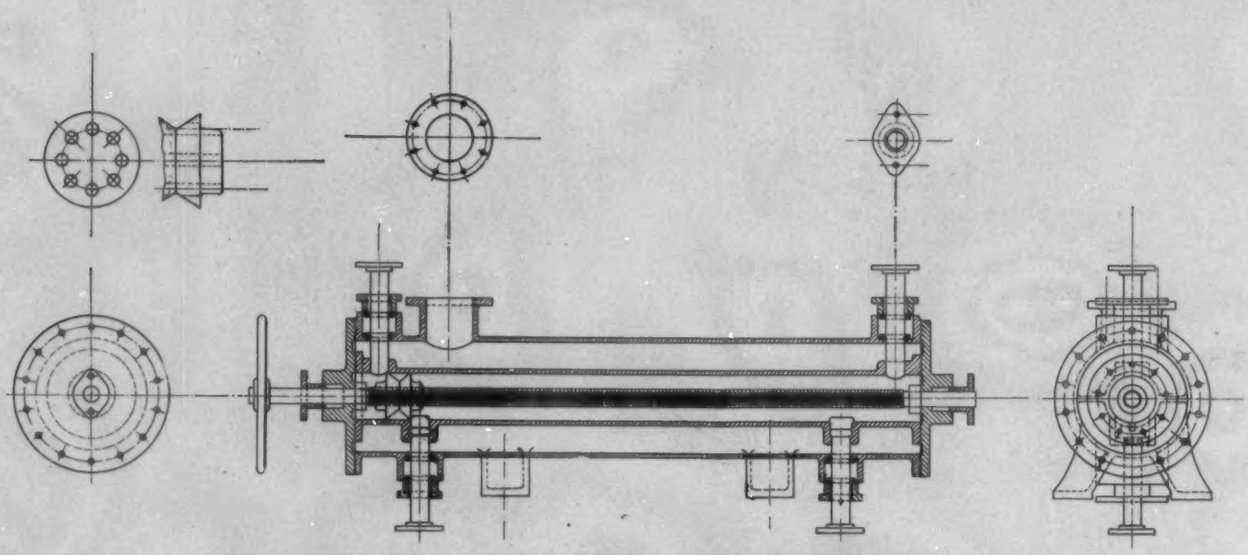


FIGURE 22. DETAIL OF CRUDE OIL SYSTEM SUPERHEATER

about 1600 degrees Fahrenheit a combination fixed oil and water gas is formed. The temperature is maintained by two Wilgus type burners using the waste or residual oil. According to the kind of crude oil or distillate employed the gas is properly purified and passed on through line 16, giving up on its course, to the water from the circulating jackets, heat available for steam making, and by pipe line 13, 12, 11, 10, 9, 8, 3 and 1 to the mixing chamber at the engine, where it is met by the air from pipes 18 and 21, maintained at a fairly constant temperature, to suit varying atmospheric conditions, by the air heater *L*. The course of the exhaust gases from the engine is by pipe 23, first warming up the air for engine slightly* to thermostat valve 25, into the lower exhaust passage of the generator *B* by nozzle 26, through and back over the top of the vaporizing chamber and out to the roof by 31, 32 and 33; also as the thermostat valve 25 closes and thermostat valve 28 opens, the gases are deflected by valve 25 up through line 27, by valve 28 and line 29, and, with valve 30 closed by line 34 (lower) through steam superheater *K*, losing heat to the steam up and back to exhaust by 34 (upper), into main exhaust 33 to roof. In the meantime the refuse oil burners pass their flame and hot gases under and back over the gas superheater *C*, out through line 36, tee-ing into line 34, following the course of the exhaust from the engine from here on, that is through steam superheater *K*, up by 34 to main exhaust 33, to roof.

Air is maintained in tanks E, E^1, E^2, at 160 pounds per square inch by means of an unloading device on the air compressor *H*. This air is used in starting the engine, in supplying the refuse oil burner used in first heating up the generator, and the refuse oil burners employed at the superheater.

*This is only deemed necessary under certain conditions of humidity or cold, since it is desirable to derive a maximum output from a given sized cylinder.

The residue from all points is led to the drainage pot *D*, from which it is ejected under pressure to the refuse oil storage to be later utililed in firing the superheater.

Summing Up. The most striking feature of this cycle is the almost complete utilization of the available heat units of the original fuel.

Chas. C. Moore & Co.'s System Compared to the Diesel.

According to the test data published in the April *Power*, 1903, the Diesel engine, with California Crude Oil, of a specific gravity 0.846 at 60 degrees Fahrenheit (equivalent to about 36 degrees Baume) gives out in its jacket water 5921 British thermal units per brake horsepower, which represents a loss of about 43 per cent. of the total heat available in the fuel.

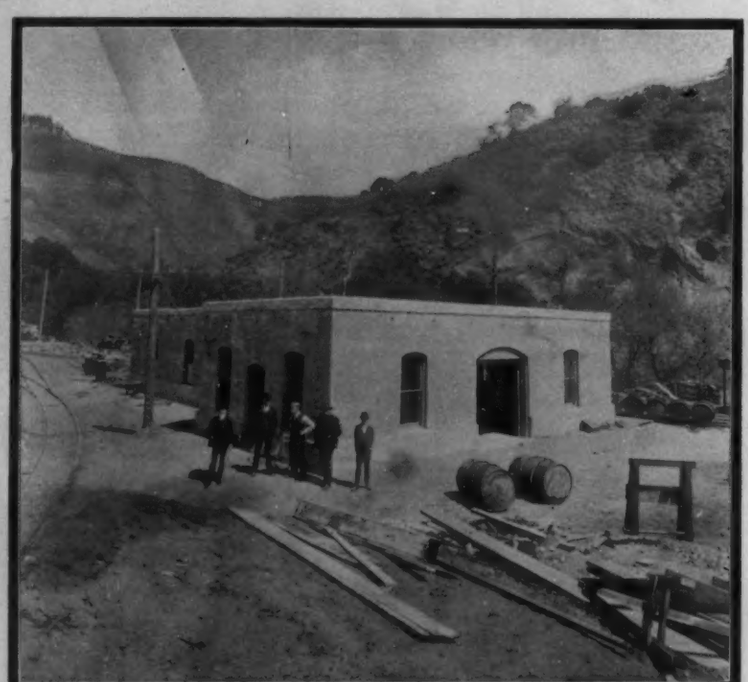


FIGURE 24. VIEW OF THE SAN JOSE AND SANTA CLARA ELECTRIC RAILWAY STATION AS FIRST INSTALLED

$$\frac{5921 \text{ B. T. W. x } 100}{0.699 \text{ pounds x } 19376 \text{ B. T. U.}} = 43 \text{ per cent.} +$$

in which

5921 B. T. U. = B. T. U. thrown out by jacket water per 1 B. H. P.
0.699 pounds = Fuel required per 1 B. H. P.
19376 B. T. U. = Calorific value of fuel per pound.

Additional to this the exhaust gases are thrown away at a comparatively high temperature.

Further, operating as does the Diesel with a compression of nearly 500 pounds per square inch and with its cylinder at a high temperature, the resulting mechanical efficiency is but 58.65 per cent. in the test noted.

On the other hand the Chas. C. Moore & Co's system permits of the use of the ordinary 16 degrees Baume crude oils sold at approximately one-half the price of the 36 degrees Baume oil used in the Diesel test.

It utilizes to a very considerable extent both the heat of the jacket water and exhaust gases.

It permits, in combination with the Westinghouse gas engines, of the realization of a much higher mechanical efficiency, since the engine is operated under normal conditions referring to temperature and pressure.

Positive scavenging, the use of a cleaned product, results in pure working mixtures, permitting of maximum economy and the maintenance of clean cylinders and valves and outweighing all other considerations the absolute reliability in continuous service, together with a certainty of a long life of parts as compared with any prime mover, gives the combination the practical qualifications required from a commercial standpoint.

In a later paper, the writer contemplates giving a full heat analysis of this interesting cycle.

In the fall of 1902 Professor G. F. Maddock, in the capacity of consulting engineer for the town of Palo Alto, derived the costs platted in Table 23 for operation with a combination Corliss and Westinghouse gas engine, using Coalinga oil at $1.22 per barrel for the latter and $.60 per barrel for the former, and in comparison with various steam engine combinations. The marked economy of the gas engine on crude oil is readily traced through the results tabulated, and giving for the gas engine, under conditions of load very trying to the internal combustion motor, and in combination with a single cylinder, non-condensing Corliss engine, the remarkably low fuel cost of $0.00319 per brake horsepower hour. By the use of Bakersfield oil at $0.60 per barrel this cost would be much lessened.

In connection with the subject of crude oil in its application to gas engines, a brief description of one of the many Westinghouse installations put in by Chas. C. Moore & Co. will not be out of place.

The San Jose and Santa Clara Electric Railway Equipment at San Jose, Cal. The station is situated at the entrance to Alum Rock Canyon, about six and one-half miles from San Jose and two and one-half miles from the the city park at Alum Rock. There is a 3 per cent.

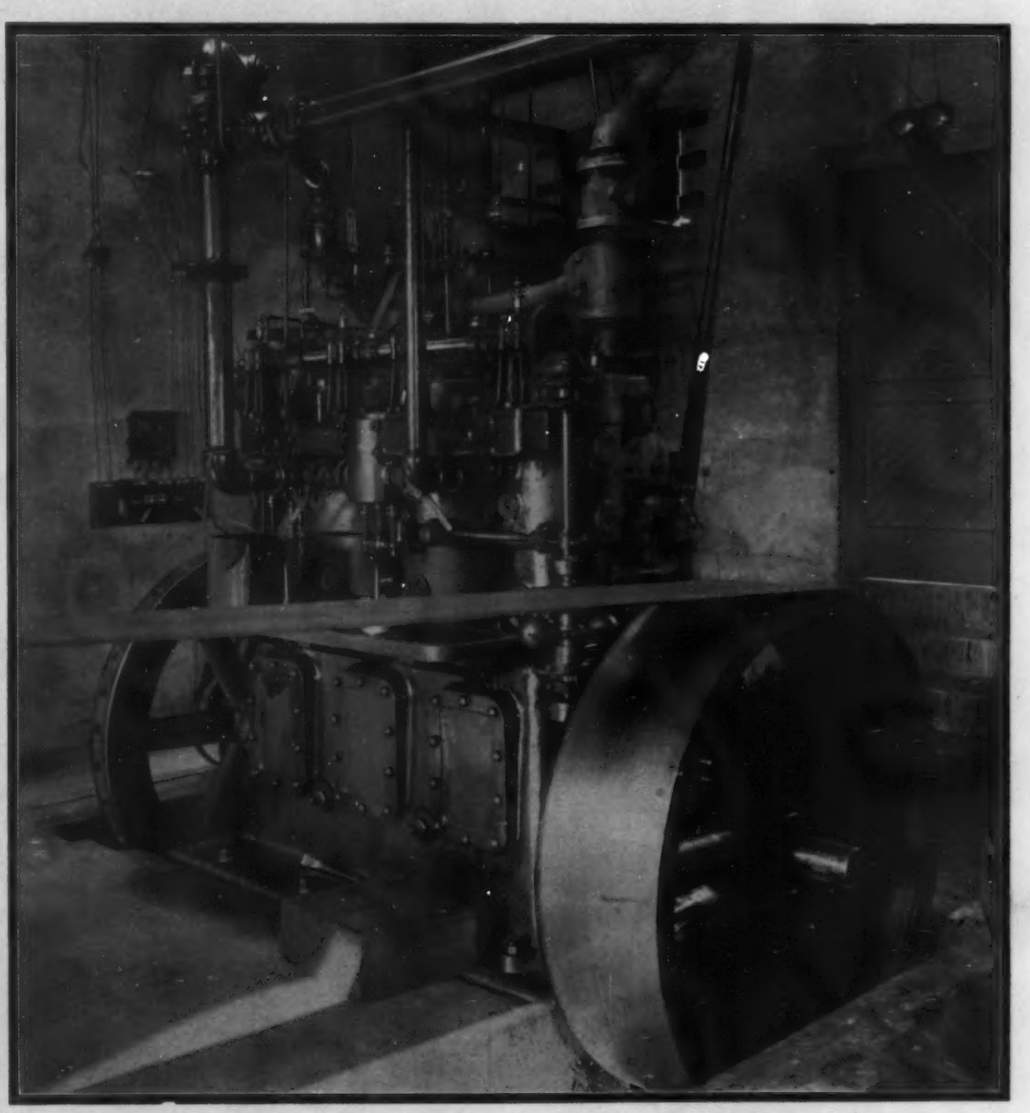


FIGURE 25. THREE-CYLINDER VERTICAL TYPE WESTINGHOUSE GAS ENGINE, ARRANGED FOR USE OF CRUDE OIL, IN THE SAN JOSE AND SANTA CLARA ELECTRIC RAILWAY STATION

TABLE 23—FUEL COST FOR OPERATING PROPOSED PALO ALTO WATER AND LIGHT PLANT.

Hours Run	Time	Average H. P.	Horsepower Hours	Units Used	Rated Capacity of Units I. H. P.	Gas Engine: Pints Oil Per H. P. Hour	Gas Engine: Total Oil Used	Average Load: Rated Load	Steam Engine: Pounds Steam Per Horsepower Hour C	Steam Engine: Pounds Steam Per Horsepower Hour W	Steam Engine: Total Steam Used
1	2	3	4	5	6	7	8	9	10	11	12
	p.m.										
1	6 to 7	73	73	C. G.	187	1.25	45.6	.40	27.2	.....	1,995
1	7 to 8	132	152	C. G.	187	.90	68.0	.82	24.0	.....	1,820
2	8 to 10	106	212	C. G.	187	1.06	56.2	.57	25.5	.....	1,350
	m.										
2	10 to 12	40	80	G.	87	1.17	94.0	.46	.....	.....	.....
	a.m.										
2	12 to 2	15	30	G.	87	1 75	52.5	.17	.....	.....	.....
2	2 to 4	40	80	G.	87	1.17	94.0	.46	.....	.....	.....
	a.m. p.m.										
12	4 to 4	80	960	G.	87	.86	825.6	.92	.....	.....	.....
2	4 to 6	34	108	G.	87	1.02	110.0	.62	.....	.....	.....
			1695				1346.0				5,165

CURVE NO. 1.

Using { Corliss..... 100 I. H. P. (C.) / Westinghouse Gas ..... 85 I. H. P. (G.) / Westinghouse Gas ..... 135 I. H. P. (G_2.) }

Corliss and Gas Engine No. 1
Total horsepower hours. = 1695
Total pints oil used..... = 1346 = 4.01 barrels @ $1.22 = $5.00
Total pounds steam used = 5167
Pounds steam for auxl.. = $\frac{775}{5940}$ (15 per cent.)

Pound steam, pounds oil = 14

$\frac{5940}{14}$ = 425 pounds oil = 1.26 barrels @ 60 cents = .76 / $5.76

Cost per I. H. P. = $\frac{5.76}{1695}$ = $0.0034 per I. H. P. hour.

	p.m.										
1	6 to 7	122	122	C. G_2.	235	1.15	70.1	.48	25.2	.....	1,540
1	7 to 8	214	214	C. G_2.	235	.91	97.5	.79	23.5	.....	2,510
2	8 to 10	160	320	C. G_2.	235	1.05	168.0	.59	23.7	.....	1,900
	a.m.										
4	10 to 2	60	240	G.	87	.97	233.0	.69	.....	.....	.....
2	2 to 4	56	112	G.	87	1 00	112.0	.64	.....	.....	.....
	p.m.										
12	4 to 4	98	1176	G.	87	.85	1000.0	1.13	.....	.....	.....
2	4 to 6	70	140	G.	87	.90	126.5	.81	.....	.....	.....
			2324				1807.1				5,950

CURVE NO. 2.

Total pints oil used = 1807 = 5.36 barrels @ $1.22 = $6.54
Total steam used.. = 5950 pounds
15 per cent..... $\frac{900}{6850}$ pounds

$\frac{6850}{14}$ = 489 pounds = 1.47 barrels @ $0.60 = .88 / $7.42

$\frac{7.42}{2324}$ = $0.0032 per horsepower hour

	p.m.										
1	6 to 7	154	154	C. G_2.	235	1.00	88.5	.66	24.5	.....	1,600
1	7 to 8	290	290	C. G_2.	235	.85	141.5	1.24	24.0	.....	3,000
2	8 to 10	215	430	C. G_2.	235	.86	212.0	.91	23.5	.....	4,300
1	10 to 11	125	125	G_2.	135	.86	107.5	.92	....	.....	.....
	a.m.										
3	11 to 2	70	210	G.	87	.90	190.0	.81	.....	.....	.....
2	2 to 4	66	132	G.	87	.93	123.0	.76	.....	.....	.....
	p.m.										
12	4 to 4	109	1310	G.	87	.85	1110.0	1.25	.....	.....	.....
2	4 to 6	80	160	G.	87	.87	138.5	.92	.....	.....	.....
			2811				2111.0				8,900

CURVE NO. 3.

Total pints oil used = 2111 = 6.3 barrels @ $1.22 = $7.69
Total steam used.. = 8900 pounds
15 per cent..... = $\frac{1335}{10235}$

$\frac{10235}{14}$ = 739 pounds oil = 2.17 barrels @ $0.60 = 1.30 / $9.00

$\frac{9.00}{2811}$ = $0.0032 per I. H. P. hour

	p.m.					G. G_2.					
1	6 to 7	205	205	C. G. G_2.	322	1.02	56.2– 86.4	.63	25.	.....	1,600
1	7 to 8	350	350	C. G. G_2.	322	.85	80.7–126.5	.10	23.5	.....	2,580
1	8 to 9	305	305	C. G. G_2.	322	.80	71.4–112.0	.94	23.5	.....	2,210
2	9 to 11	230	460	C. G_2.	235	.85	225.0	.98	23.5	... ..	4,610
	a.m.										
3	11 to 2	110	330	G_2.	135	.90	297.0	.82	.....	.....	.....
2	2 to 4	74	148	G_2.	135	1.08	160.0	.55	.....	.....	.....
	p,m.										
12	4 to 4	118	1418	G_2.	135	.88	1248.0	.87	.....	.....	.....
2	4 to 6	90	180	G.	87	.85	153.0	1.03	.....	.....	.....
			3396				2641.0				10,900

CURVE NO. 4.

Total pints oil used = 2614 = 7.77 barrels @ $1.22 = $9.49
Total steam used = 10,900 pounds
15 per cent..... = $\frac{1,635}{12,535}$ pounds

$\frac{12535}{14}$ = 900 pounds oil = 2.68 barrels @ $0.60 = 1.61 / $10.10

$\frac{10.10}{3396}$ = $0.00298 per I. H. P. hour

	p.m.											
1	6 to 7	73	73	W	200	.36	.....	.....	.....	27	1,970	Using { Corliss..... 100 I. H. P. (C.) Westinghouse Compound. 200 I. H. P. (W.)
1	7 to 8	152	152	W	200	.76	.....	.....	.....	23½	3,570	
1	8 to 9	130	130	W	200	.65	.....	.....	.....	24	3,120	CURVE NO. 1.
	a.m.											
4	9 to 1	60	240	C	100	.60	.....	.....	25	.....	1,500	Total steam used = 36,310 pounds
1	1 to 2	10	10	C	100	.10	.....	.....	70	.....	700	15 per cent..... = 5,448
2	2 to 4	40	80	C	100	.40	.....	.....	27	.....	2,200	41,758 pounds
	p.m.											
12	4 to 4	71	842	C	100	.71	.....	.....	24½	.....	20,600	$\frac{41,758}{14}$ = 3000 pints oil = 8.93 barrels @ $0.75 = $7.00
2	4 to 6	52	102	C	100	.52	.....	.....	26	.....	2,650	
			1629								36,310	$\frac{7.00}{1629}$ $0.00411 per I. H. P. hour
	p.m.											
1	6 to 7	122	122	W	200	.61	.....	.....	.....	24¼	2,960	CURVE NO. 2
1	7 to 8	214	214	W	200	1.07	.....	.....	.....	23½	5,040	Total steam used = 55,510 pounds
2	8 to 10	160	320	W	200	.80	.....	.....	.....	23½	7,500	15 per cent..... = 8,350
	a.m.											63,860 pounds
4	10 to 2	60	240	C	100	.60	.....	.....	25½	.....	6,130	$\frac{63,860}{14}$ = 4560 pints oil = 13.6 barrels @ $0.75 = $10.20
2	2 to 4	56	112	C	100	.56	.....	.....	25½	.....	2.850	
12	4 to 6	98	1175	C	100	.98	.....	.....	23½	.....	27,600	$\frac{10.20}{2323}$ = $0.00439 per I. H. P. hour
2	4 to 6	70	140	C	100	.70	.....	.....	24½	.....	3,430	
			2323								55,510	
	p.m.											
1	6 to 7	154	154	W. C.	300	.51	.....	.....	25	27	{ 2,580 1,380	
1	7 to 8	290	290	W. C.	300	1.00	.....	.....	23½	23½	6,810	CURVE NO. 3
3	8 to 11	190	570	W. C.	300	.66	.....	.....	24	26	{ 9,120 4.940	Total steam used = 68,020 pounds
	a.m.											15 per cent..... = 10,200
3	11 to 2	70	210	C.	100	.70	.....	.....	.....	24½	5,150	78,220
2	2 to 4	66	132	C.	100	.66	.....	.....	.....	26	3,440	$\frac{78,220}{14}$ = 5580 pints oil = 16.65 barrels @ $0.75 = $12.48
	p.m.											
12	4 to 4	109	1310	C.	100	1.09	.....	.....	.....	23½	30,760	$\frac{12.48}{2926}$ = $0.00442 per I. H. P. hour
2	4 to 6	80	160	C.	100	.80	.....	.....	.....	24	3,840	
			2926								68,020	
	p.m.											
1	6 to 7	205	205	W. C.	300	.67	.....	.....	25	24	{ 3,290 1,700	
1	7 to 8	350	350	W. C.	300	1.16	.....	.....	23½	23½	8,220	CURVE NO. 4.
1	8 to 9	305	305	W. C.	300	1.00	.....	.....	23½	23½	7,180	Total steam used = 80,885 pounds
3	9 to 11	200	600	W. C.	300	.66	.....	.....	25	24	{ 9,600 5,000	15 per cent..... = 12,100
	a.m.											92,985
2	12 to 2	85	170	C	100	.85	.....	.....	24	.....	4,080	$\frac{92,985}{14+336}$ = 19.75 barrels oil @ $0.75 = $14.80
2	2 to 4	74	148	C	100	.74	.....	.....	24	.....	3,550	
	p.m.											
12	4 to 4	118	1418	C	100	1.18	.....	.....	24	.....	34,040	$\frac{14.80}{3376}$ = $0.0044 per I. H. P. hour.
2	4 to 6	90	180	C	100	.90	.....	.....	23½	.....	4,225	
			3376								80,885	
	p.m.											
1	6 to 7	73	73	Comp.	275	.28	.....	.....	20	.....	1,460	Using Corliss Compound.
1	7 to 8	152	152	Comp.	275	.55	.....	.....	18	.....	2,740	CURVE NO. 1.
1	8 to 9	130	130	Comp.	275	.473	.....	.....	19	.....	2,470	Total steam used = 37,185
1	9 to 10	82	82	Comp.	275	.30	.....	.....	20	.....	1,640	15 per cent..... = 5,560
	a.m.											42,745 pounds
3	10 to 1	35	105	12 in. cyl.	100	.35	.....	.....	26	.....	2,725	$\frac{42,745}{14 \times 336}$ = 8.94 barrels @ $0.75 = $6.70
1	1 to 2	10	10	12 in. cyl.	100	.35	.....	.....	70	.....	700	
	p.m.											
14	2 to 6		1042	12 in. cyl.	100	.....	.....	.....	.....	.....	25,450	$\frac{6.70}{1594}$ = $0.00420 per I. H. P. hour
			1594								37,185	

Hours Run	Time	Average H. P.	Horse-power Hours	Units Used	Rated Capacity of Units I. H. P.	Gas Engines: Pints Oil Per H. P. Hour	Gas Engines: Total Oil Used	Average Load: Rated Load	Steam Engine: Pounds Steam Per Horse-Power Hour C	Steam Engine: Pounds Steam Per Horse-Power Hour W	Steam Engine: Total Steam Used	
1	2	3	4	5	6	7	8	9	10	11	12	
	p.m.											
1	6 to 7	122	122	Comp.	275	.43	.....	.....	19	.....	2,310	Using Corliss Compound.
1	7 to 8	214	214	Comp.	275	.78	.....	.....	17½	.....	3,740	
2	8 to 10	80	160	Comp.	275	.58	.....	.....	18	.....	5,760	CURVE NO. 2.
1	10 to 11	95	95	Comp.	275	.35	.....	.....	19	.....	1,810	Total steam used = 45,470 pounds
	a.m.											15 per cent..... = 6,820
3	11 to 2	50	150	Single	100	.50	.....	.....	26	.....	3,900	52,290 pounds
2	2 to 4	56	112	Single	100	.56	.....	.....	25½	.....	2,850	
	p.m.											$\frac{52,290}{14\times336}$ = 11.10 barrels @ $0.75 = $8.32
12	4 to 4	98	1175	Comp.	275	.36	.....	.....	19	.....	22,300	
2	4 to 6	70	140	Comp.	275	.27	.....	.....	20	.....	2,800	$\frac{8.32}{2328}$ $0.00357 per I. H. P. hour.
			2328								45,470	
	p.m.											
1	6 to 7	154	154	Comp.	275	.56	.....	.....	18	.....	2,770	CURVE NO. 3.
1	7 to 8	290	290	Comp.	275	1.09	.....	.....	16	.....	4,640	
3	8 to 11	190	570	Comp.	275	.69	.....	.....	17	.....	9,200	Total steam used = 52,280 pounds
	a.m.											15 per cent..... = 7,850
3	11 to 2	70	210	Comp.	275	.25	.....	.....	22	.....	4.620	60,130
2	2 to 4	66	132	Comp.	275	.24	.....	.....	22½	.....	2,930	
	p.m.											$\frac{60,130}{14\times336}$ 12.77 barrels @ $0.75 = $9.57
12	4 to 4	109	1310	Comp.	275	.40	.....	.....	19	.....	24,900	
2	4 to 6	80	160	Comp.	275	.29	.....	.....	20	.....	3,200	$\frac{9.57}{2824}$ = $0.00342 per I. H. P. hour
			2824								52,280	
	p.m.											
1	6 to 7	205	205	Comp.	275	.75	.....	.....	16½	.....	3,380	CURVE NO. 4.
1	7 to 8	350	350	Comp.	275	1 27	.....	.....	18	.....	6.300	
1	8 to 9	305	305	Comp.	275	1.12	.....	.....	17	.....	5,200	Total steam used = 61,150 pounds
3	9 to 12	200	600	Comp.	575	.73	.....	.....	17	.....	10,200	15 per cent..... = 9,180
	a.m.											70,330 pounds
2	12 to 2	85	170	Comp.	275	.31	.....	.....	20	.....	3,400	
2	2 to 4	74	148	Comp.	275	.28	.....	.....	20	.....	2,960	$\frac{70,330}{14\times336}$ = 14 92 barrels @ $0.75 = $11.20
	p.m.											
12	4 to 4	118	1418	Comp.	275	.43	.....	.....	18½	.....	26,200	
2	4 to 6	90	180	Comp.	275	.33	.....	.....	19½	.....	3,510	$\frac{11.20}{3376}$ = $0.00332 per I. H. P. hour
			3376								61,150	

Legend

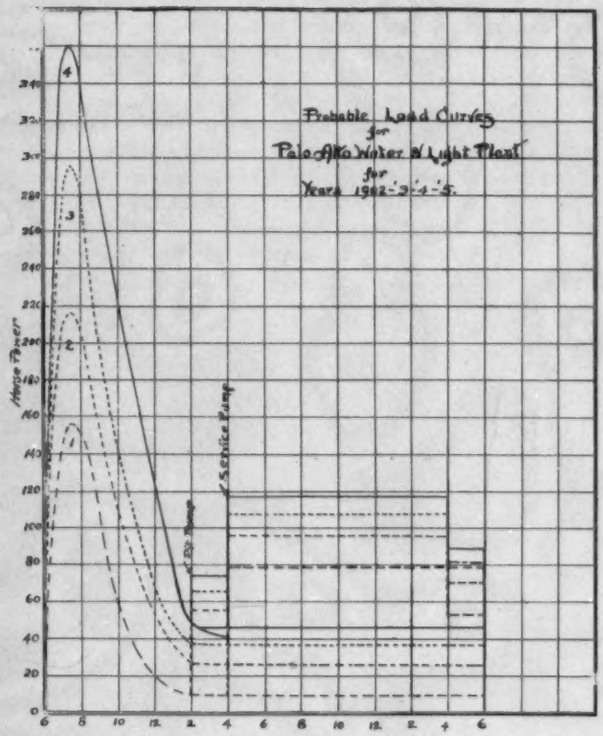
C—Corliss, 12x36 inches, 100 I. H. P.
G—Westinghouse Gas, 11x12 inches, 85 I. H. P.
G_2—Westinghouse Gas, 13x14 inches, 135 I. H. P.
W—Westinghouse 14x24x14 inches Compound Steam Engine, 200 I. H. P.
C_2—22x36 inch Corliss.
Comp.—C. and C_2

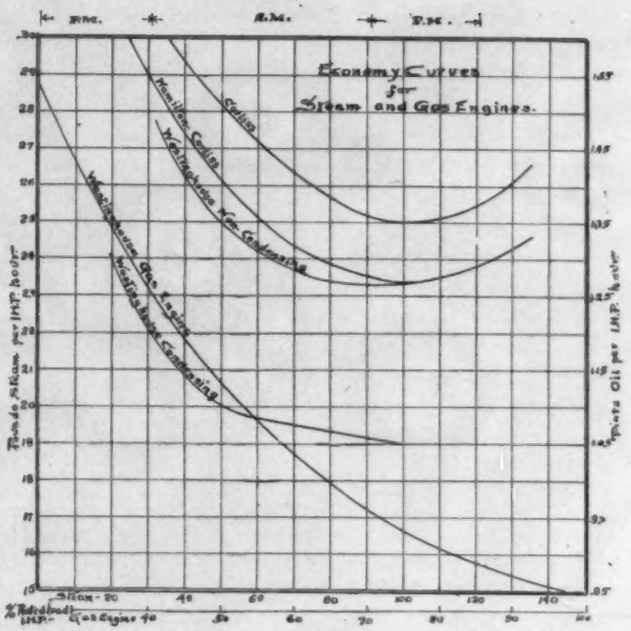
Average Cost per I. H. P. hour.

Running present Corliss with Westinghouse Gas Engines	$0.00319
By planimeter measurement	.00319
Runniug present Corliss with Westinghouse Compound non-condensing steam engine	$0.00433
By planimeter measnrement	.00429
Running present Corliss with 22x36 inch Corliss as cross-compound condensing or present engine as simple non-condensing	$0.00363
By planimeter measurement	.00355

Remarks

Planimeter area Curve No. 1, 1700 H. P. hours.
Planimeter area Curve No. 2, 2358 H. P. hours.
Planimeter area Curve No. 3, 2820 H. P. hours.
Planimeter area Curve No. 4, 3440 H. P. hours.
Coalinga oil used for gas engine at $1.22 barrel at works.
Charged for residue oil from gas engine to operate steam engine, $0.60 barrel.
Bakersfield oil used to generate steam for Westinghouse and Corliss steam engines at $0.75 barrel at works.





grade from the station to the end of the canyon and another slight grade on the San Jose side. The station was situated with a view to effect the most economical distribution of current. The company's road also includes an extensive system to San Jose.

Arranged to operate on crude oil is a Westinghouse three-cylinder, 11x12 inch, vertical type engine operating at 290 revolutions per minute. The engine is shown in Figure 25. The outside of the power house is seen in Figure 24, in which, starting from the right, the second gentleman is Mr. Hugh Center, the manager, whereas the second from the left is Professor George F. Maddox, of Leland Stanford University.

The electric equipment is partially shown in Figure 26, while Figure 27 is illustrative of the storage battery room. Belted to the engine is an Edison bi-polar generator. A differential booster and a switchboard, including a generator panel, a battery panel and a booster panel are also shown.

The battery room adjoins the engine room, and in it are installed 264 chloride accumulators, type 7-F, having a one hour discharge rate of 120 amperes, with glass jars of type 13-F, allowing for 100 per cent. increase in capacity. The engines are of sufficient capacity to take the average load during the heavy travel in summer, the battery taking all fluctuations above the average, and thus maintaining a steady full load on the generator.

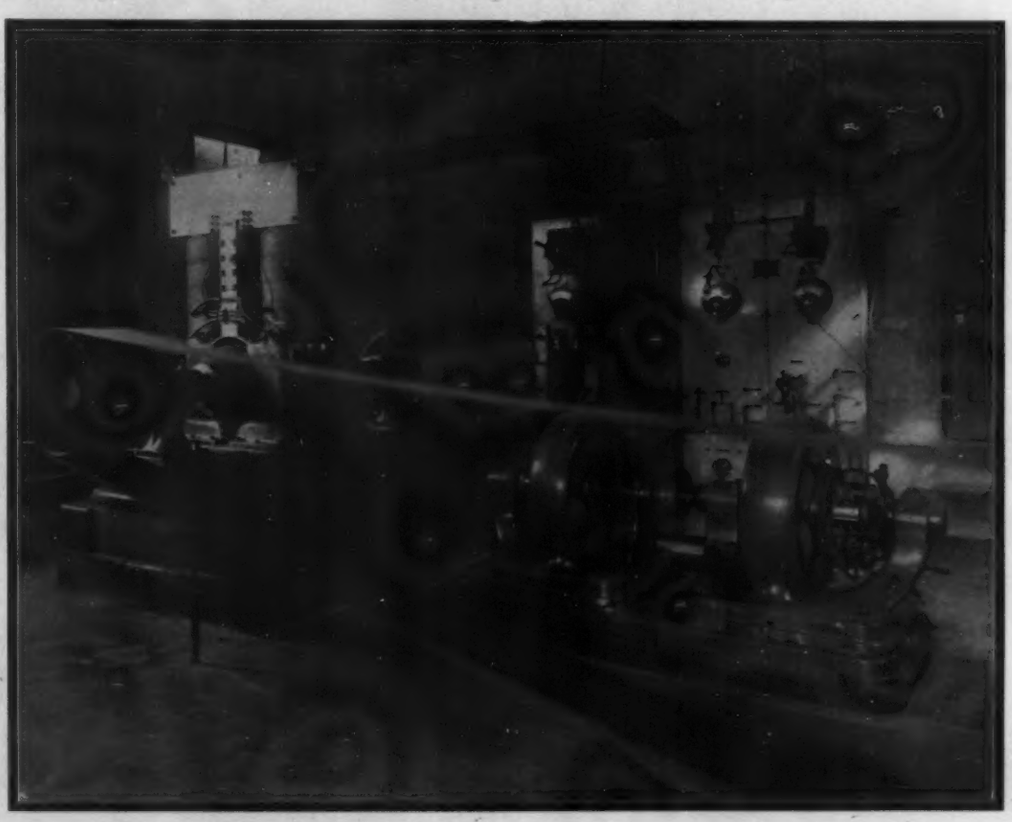


FIGURE 26. ELECTRIC EQUIPMENT OF THE SAN JOS EAND SANTA CLARA ELECTRIC RAILWAY STATION

Charged for reading on steam engines at $0.75 barrel at works.
Bakersfield oil used to generate steam for Westinghouse and Corliss

The engine already referred to was installed a little more than a year ago, and has operated entirely on crude oil. The station has just been enlarged (Figure 28) by the addition of a two-cylinder, 13x14 inch Westinghouse verlical type engine (Figure 29). The available brake horsepower for maximum load with both engines on a crude oil rating is about 250.

Mr. George L. Center, president of the road, states that the service has been very satisfactory, that they have never had a shut-down, and that the cost for crude oil at $1.13 per barrel has been within $\frac{3}{10}$ cents and $\frac{4}{10}$ cents per kilowatt hour.

Other plants installed for operation on crude oil include the Winters Water Works, the Tonopah Light and Power Company and the Chase Nursery Company.

CRUDE OIL AS A FUEL.*

BY A. M. HUNT.

A PERSON who reads or listens to an article on the use of crude oil fuel should bear in mind the old adage that "figures cannot lie," but at the same time he should not lose sight of the equally true if not so commonly used expression, that "liars will figure." I shall, however, in the present instance, endeavor to deal with absolute facts, and the data used and the figures given are those obtained in my own actual experience, not relying in any particular on items which I have not verified personally.

Since 1894 I have been connected with various plants on the coast, using large amounts of California crude oil as fuel, of all grades, from very light to very heavy. At the Mid-Winter Fair in this city I had under my charge a boiler plant of 3000 horsepower, using fuel oil exclusively for a period of six months. For the past three years I have been general manager of the Independent Electric Light and Power Company, which is now using an average of over 300 barrels daily.

The question is frequently raised as to what oil is best adapted for fuel purposes, and gives the greatest va'ue per dollar expended. Within the range of fuel oils on the market today there is very little choice. Most of the oil sold for fuel purposes ranges in gravity from 14 degrees Baume to 20 degrees Baume, and the persons producing light and heavy oil each present arguments in favor of their product, attempting to prove that it has higher heat values.

In considering this question it must be borne in mind that oil is always purchased by measure and not by weight. It is true that the lighter gravity oils contain a slightly greater number of heat units per pound than the heavier oils, but in buying a gallon of heavy oil a person obtains more pounds of fuel than in the case of light oils. In the operation of the Independent Company's plant, very careful records have been kept of the amount of oil consumed and of power produced for a period of over two years. During the first year, the oil used was of heavy grade, averaging about 14½ degrees Baume. During the second year, the oil used varied from about 18 to 20 degrees Baume. Taking the total records of the two years, if there is any difference whatever in the results obtained, I should say it was slightly in favor of the heavier oil, although the difference is so slight that it might be accounted for by factors other than the oil. The heavier an oil is the more difficult it is to force it through small pipes and connections of a plant. By properly arranging the devices, however, this point offers no difficulty, and if I were contracting today for fuel oil, I would not pay a fraction of a cent difference per barrel for one gravity of oil over another, within the limits of the oil that is handled in the San Francisco market.

The principal application of oil for fuel is in the production of steam for various uses, and the measure of value of the oil is usually taken as the number of pounds of water which the oil will evaporate, and in order that different instances may be brought to a common basis for comparison, the actual evaporation is always figured as what the evaporation would be from water at 212 degrees Fahrenheit. I have made a very great many tests at different times during the past eight years on this point, using boilers of different makes. The best results I have ever been able to obtain, under the favorable conditions, and with efficient types of boilers, has been an evaporation of 15½ pounds of water per pound of oil from and at 212 degrees Fahrenheit, and this only when the load on the boiler was maintained uniformly during the test at the best point of economy for the boiler. I have frequently seen claims made of higher evaporation than this, but have always been inclined to discredit them. Not many years ago there was a man in this city who claimed by the use of his particular type of burner to produce an evaporation that would require the oil to develop heat units in excess of what the oil actually contained; in other words, to produce something out of nothing.

In installing an oil-burning plant, the question of what type of burner to use is one that causes a great deal of worry to the average man. The number of burners on the market is enormous, each claiming to be better than any other and to produce results that exceed those obtainable by any other type. During the present year there has been undertaken by the Navy Department a series of tests as to the adaptability of oil for fuel purposes on our men-of-war vessels, and there has lately been issued in the annual report of Admiral Melville, chief of the Bureau of Steam Engineering, a preliminary statement by the board having this matter in charge. The work which has been undertaken will certainly prove of great value to all users of petroleum fuel, and the undoubted impartiality and honesty of this board gives greater weight to its statements than the usual run of reports and tests of similar character. I quote several selections which indicate the opinion of the members of this board on the question of burners, and can state that my own experience confirms them:

"That the efficiency of oil fuel plants will be greatly dependent upon the general character of the installation of auxiliaries and

FIGURE 27. STORAGE BATTERY ROOM OF THE SAN JOSE AND SANTA CLARA ELECTRIC RAILWAY POWER HOUSE

*A paper read before the 11th Annual Convention of the California Miners' Association, San Francisco, November 17, 18, 19, 1902.

fittings, and, therefore, the work should only be intrusted to those who have given careful study to the matter, and who have had extended experience in burning the crude product. The form of the burner will play a very small part in increasing the use of crude petroleum. The method and character of the installation will count for much, but where burners are simple in design and are constructed in accordance with scientific principles there will be very little difference in their efficiency. Consumers should principally look out that they do not purchase appliances that have been untried and have been designed by persons who have had but limited experience in operating oil devices." * * * *

FIGURE 30. TERMINAL OF THE SAN JOSE AN SANTA CLARA ELECTRIC RAILWAY STATION

"There are on file in this bureau over 2000 drawings and specifications pertaining to the use of liquid fuel and it is said that new patents are being issued at the rate of about thirty a week."

* * * * "There has been sufcient evidence already produced to prove that in all probability special forms of burner willbe required for different types of boilers."

A further point that is frequently raised in considering the use of petroleum is as to its relative value, compared with coal, and in connection with mining installations, the comparison must often be made with wood. It should be borne in mind, in making any such comparison, that the words coal or wood do not express any standard, as there is extremely great variation between different coals and different kinds of wood. Crude petroleum, however, so far at least as produced on this coast, is fairly uniform in heat-producing power. Taking the result of my experience with coast coals, and assuming Wellington coal as a standard, I should give their relative values as being about four to four and one-fourth barrels of crude oil equal to one long ton of average Wellington coal. Taking the average wood used for fuel in California, I should place approximately two cords of wood equal to one ton of coal. I have frequently heard oil men give the relative value of oil and coal as three and one-half barrels of oil per ton of coal, but consider that this figure is apt to lead to disappointment when actual tests are made.

I have been asked to make a hurried comparison as to the cost of power developed on tide water of San Francisco, in large units, using fuel oil, with the cost of delivery of electric power over a long distance line, assuming the power to be produced from some one of our many mountain streams. In making this comparison, I was asked to take plants capable of delivering 50,000 horsepower each, and assume the distance of transmission to be 200 miles.

The data which I have used for the steam plant is as follows:

That the plant shall contain eight 5000-kilowatt steam turbine driven alternators, and to be fitted with the best type of boilers, auxiliaries and all devices for economy. I have the price of fuel at 55 cents per barrel, at which rate long term contracts have been made for large quantities of oil within the past few months. I have assumed that the hydraulic plant will have an equal number of units driven by impulse wheels; that the distance of transmission, as before stated, will be 200 miles, and the voltage for transmission 60,000.

In order to eliminate as many items from the comparisons as possible, I have made a close estimate of the cost of the steam plant, the data of which can be absolutety determined, and I would state that this estimate is based on present prices of machinery, and confirmed by the results obtained in the erection of large plants within the past few years. In the case of the hydraulic plant, these elements are not absolutely determinable, as each individual case is a law unto itself.

FIGURE 28. VIEW OF THE SAN JOSE AND SANTA CLARA ELECTRIC RAILWAY STATION AS ENLARGED

The cost per horsepower installed in the steam plant is, however, such that I can positively state that to equal it in any hydraulic plant, taking into account the hydraulic development, powerhouse machinery and everything up to the point where the power goes on to the line, would require that the conditions should be extremely favorably, and I doubt whether there is any locality in California, at least none with which I am acquainted,

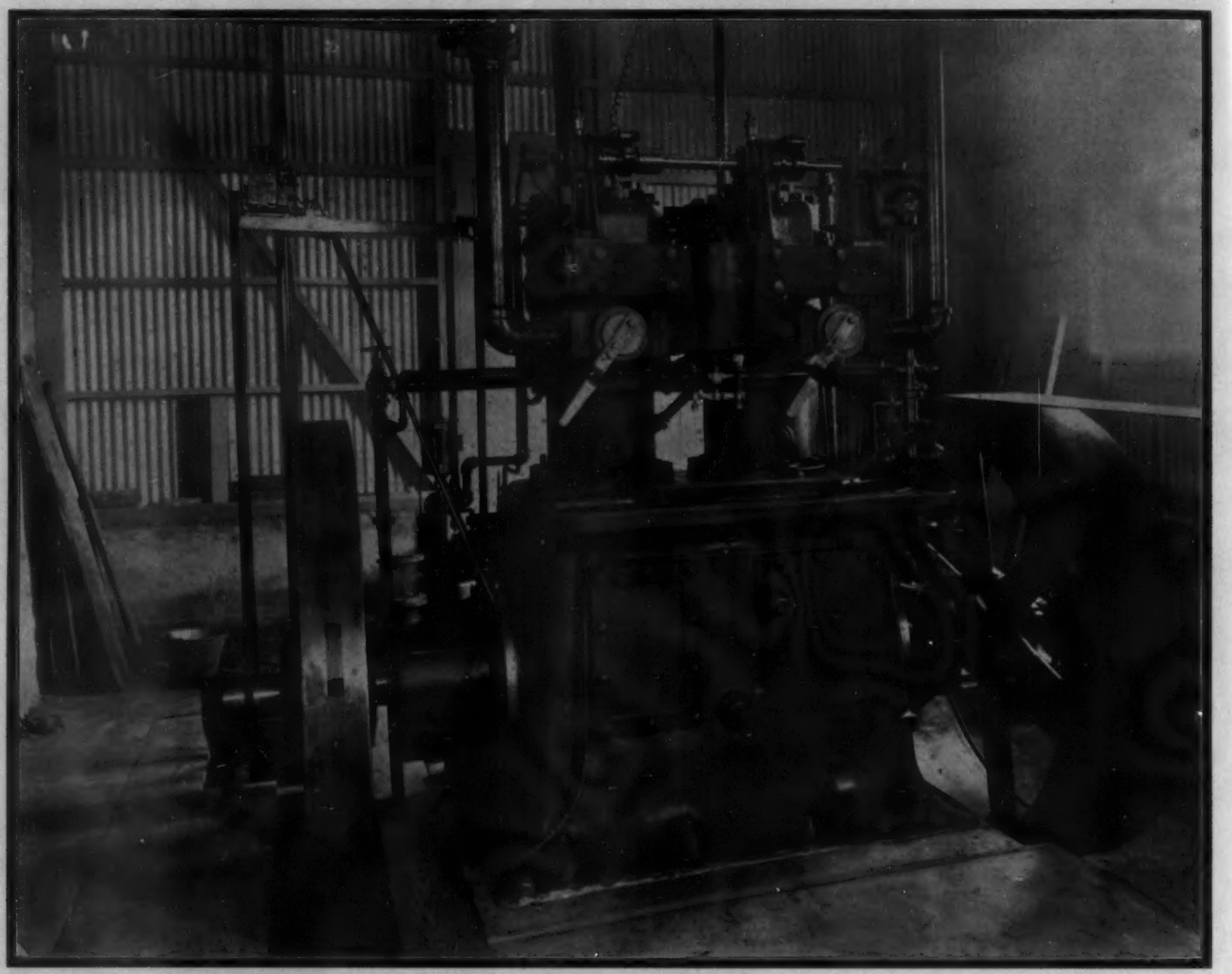


FIGURE 29. TWO-CYLINDER VERTICAL TYPE WESTINGHOUSE GAS ENGINE ARRANGED FOR THE USE OF CRUDE OIL IN THE SAN JOSE AND SANTA CLARA ELECTRIC RAILWAY STATION

that would permit an equally low cost. The amount of labor in the steam plant, using such units as have been indicated, and with the small amount of labor required in operating a boiler plant using oil, would be no greater than the labor required to operate the hydraulic plant and care for the water system. The items of cost which should be compared and which I have assumed and taken, are the interest, depreciation and taxes on the cost of the pole line and the cost of patrolling and caring for same; in the steam plant, the cost of fuel, water required for steam, and miscellaneous supplies. The amount of fuel required to produce the power I have taken from the actual results and experiences in plants which I have operated, and while the conditions are such that it is not possible for me to lay before you in detail the record of operation of these plants, I can assure you that the figures are absolute and correct. It is probable that any figures which I may lay before you will be criticized and attacked, but I have endeavored to give them without bias or prejudice, in order that the comparison may be absolutely fair.

The amount of copper required to transmit 50,000 horsepower a distance of 200 miles, at 10 per cent. loss under normal conditions, is approximately 16,000,000 pounds. It would be absolutely necessary to erect at least two distinct and separate transmission lines, in order to guarantee continuous operation. I have figured on using a form of tower construction that would make stability the first item of consideration, and would give as my estimate of the cost of such lines $3,500,000, which would cover cost of material and erection, rights of way, etc.

I will take first the cost per horsepower, when same is called for and taken twenty-four hours daily for 365 days per year. In the case of the water power plant, it is immaterial what the

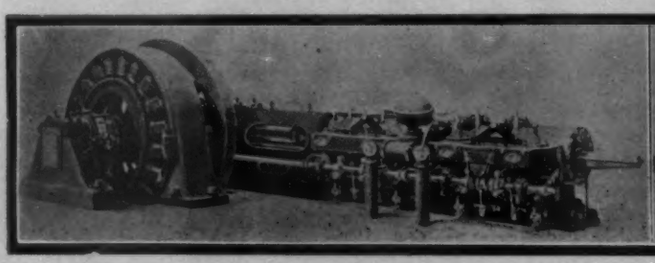


FIGURE 31. HORIZONTAL TYPE SINGLE CRANK DOUBLE ACTING WESTINGHOUSE GAS ENGINE

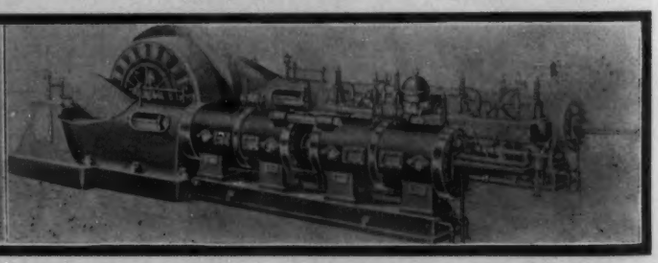


FIGURE 32. HORIZONTAL TYPE DOUBLE CRANK DOUBLE ACTING WESTINGHOUSE GAS ENGINE

number of hours maybe. The cost of operation per horsepower of plant installed remains the same, as the operating cost is a lump sum which does not vary with the number of hours' use made of the current. I have assumed, for the purposes of calculation, that interest, depreciation, taxes and all other charges against the pole lines will be covered by 12 per cent. on the investment therein, and I do not think that this is in any way excessive. The total charge, therefore, against the pole line would be $420,000 yearly, or the sum of $8.40 per horsepower per year.

Under similar circumstances, operating the steam plant twenty-four hours daily and three hundred and sixty five days per year, the output of the steam plant per horsepower installed would be $19.68, showing a very great advantage for the water power. However, there is no instance in which power is taken twenty-four hours daily and for the entire year. It must be remembered that these figures do not represent the actual cost of producing power, but are only the cost of the items not common to the two cases compared.

I have made a second comparison, taking the actual operating conditions as they obtain in the city of San Francisco, in a plant carrying both power and lighting load, as well as a portion of the street railway system. The load of this plant is absolutely representative of the local conditions, and any person figuring on entering San Francisco market with transmitted power must figure on the conditions as they actually exist. It should be borne in mind that during the winter time the amount of load taken by practically all consumers is very considerably increased, and that they will all make heavy demands for a very limited time in the evening during such months. As an example, all factories operating and taking current from an electric power company, needs lights for a comparatively short time, at period between half past four in the afternoon and the time of closing, and to meet this demand machinery must be installed which will be entirely idle during a great part of the year, and only operated for a short time daily during the balance of the year.

It will be very surprising to any of you to know the actual facts with reference to the street railroad load in the city of San Francisco. I believe I am well within bounds, basing what I say on information received from parties well informed on the matter, that the maximum load during the twenty-four hours on the street railway system is at least three times the average, figured on a twenty-four hour basis. Taking the cost for delivery of power, under conditions as they actually exist with the hydraulic plant, the cost would be $8.40 per horsepower per year. With the steam plant this figure becomes $5.72, showing that with the conditions as they exist at the present time the character and class of load being taken from actual results, the price of fuel being taken on the basis of contracts lately made, the steam plant has the advantage.

In this connection it should furthermore be borne in mind that there is little or no probability of the cost of transmitted power being reduced. The only way in which the charges under consideration in the present instance could be lowered would be by increasing the voltage at which the line is operated. It seems to be the general concensus of opinion, and as the results of experiments made, that the voltage of 60,000 is as high as we may expect to see used unless some radical unforeseen developments take place. The converse is the case with reference to power generation from fuel. The entire engineering world is at the present time in a state of ferment over the solution of this problem. Internal combustion engines are being developed more and more, and types in which oil may be used direct in the cylinders of the engine are coming to the front and promise practical results. The Diesel motor has lately been taken hold of by a large company in New York, and will be vigorously exploited in this country. Reliable tests show that it will yield a horsepower with two-thirds, if not less, of the amount of fuel used by the best engine. A new type of oil engine, of 200 horsepower, is under construction in this city at the present time that promises to give a horsepower on less than one-half of the fuel oil used with the best steam engine. And it seems more than probable that within a very few years present results will be greatly improved.

With the amount of fuel oil which is being produced on the Pacific Coast and the conditions which exist with reference to other fuels it has always seemed to me that it should be adapted to a greater variety of uses. A considerable amount of work is being done at the present time in the utilization of crude oil to the exclusion of coal in the production of gas, and this promises to become a quite important factor in the crude oil market. There is no reason why crude oil should not be applied to forge work and heating furnaces, and this is done in some of the Eastern manufactories, not only on the score of less cost, but greater convenience. I see no reason why the high-priced coke used by founders should not be replaced by crude oil. It would involve the necessity of modified forms of cupolas and possibly the adoption of some type of hearth furnace, but the incentive would seem to me sufficient to justify experiment in this direction. If iron is ever to be smelted on this coast, it would seem that it must be done with oil fuel, or at least with its aid. It is believed by leading metallurgists that the presence of solid carbon is necessary to the reduction of iron ore, but even this factor does not necessarily preclude the use of crude oil, as it contains on the average approximately 84 per cent. of carbon, and it is by no means an impossibility that the problem may be successively solved.

GAS ENGINES IN GREAT UNITS.*

BY PROFESSOR J. J. FLATHER.

GAS engines have grown rapidly in size during the last two years, as is shown by the fact that one manufacturer is now constructing a gas engine of an output of 2500 horsepower and is prepared to build up to 5000 horsepower. The development of the large gas engine is closely connected with the evolution of the fuel gas processes, and it is noteworthy that the first gas engines in Great Britain above 400 horsepower were operated with producer gas, while many of the large gas engines in Continental Europe have been built for use with blast furnace gas. The use to which gas engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution.

While the gas engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use gas engines direct as motors. A number of railway and other machine shops have been equipped with moderate sized gas engines suitably located about the works, and, in addition, thousands of horsepower are used in the smaller sizes for a wide variety of purposes, including village water-works, isolated lighting stations, and manufacturing plants of all kinds.

With the possibilities of high thermal efficiencies one may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas engine into very general succession to the electric motor for many purposes, for it may possibly be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use effect a material saving in the utilization of power over any existing methods.

It is not to be presumed that the gas engine will displace either the electric motor or the steam engine. Each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas engine will be extended more and more into that of the steam engine and the electric motor.

As to the steam turbine, it is fair to presume that its present limitations are not insuperable and that the atteution which is now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

*An abstract of an article appearing in *Cassier's Magazine*, Volume XXIII, page 725; April, 1903.

The Journal of ELECTRICITY POWER and GAS
DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

PUBLISHED MONTHLY BY
The Journal of Electricity Publishing Company
144 Union Square Avenue, San Francisco, Cal.
Telephone Bush 519.

Official Organ of the Pacific Coast Electric Transmission Association.

Yearly subscription: Domestic, $2.00; Foreign, $2.50; Single Copies, 25 cents.
Subscriptions can not be begun with back numbers.
Manuscripts to be returned if rejected must be accompanied by return postage.
Address all communications and make all remittances payable to The Journal of Electricity Publishing Company.

Notice to Publishers
This number is copyrighted by The Journal of Electricity Publishing Company

Entered as second-class matter at the San Francisco Post Office, August 15, 1899.
Entered as *The Electrical Journal*, July, 1895. Entry changed to *The Journal of Electricity*, September, 1895.

VOLUME XIII MAY, 1903 NUMBER 5

EDITORIAL.

IT IS COMING WESTWARD.

Members of The American Institute of Electrical Engineers, whether of the Atlantic or of the Pacific seaboards, or whether of the great central empires of the country, cannot but note with satisfaction that the Institute Council, practically for the first time, has recognized the West by allotting to it the nomination for the presidency. And inasmuch as the Council nomination is the virtual equivalent of an election, it is safe to predict that the next president will be Bion J. Arnold, of Chicago, and that in his election the energy of the West will be united to that of the East for the elevation of the Institute to a higher plane of usefulness.

The thought cannot be suppressed that in Mr. Arnold's election is inspired a hope that possibly the near future will find the name of a man of the Pacific West standing high in the list of Institute officialdom. Men of calibre are here, and their recognition in the direction indicated is sure to come sooner or later, and when it does come the influence of the Institute on the Pacific Coast will be increased a hundred fold.

CHEAP POWER IN PERPETUITY.

From a perusal of one of the several invaluable papers contributed to this number of THE JOURNAL it will be seen that the great "gushers" of the Texas oil fields do not indicate a permanent supply in that State, and that the chances for permanency lies rather with slow flowing wells, such as are characteristic of the oil fields of California, than with the extraordinarily quick producers of the Lone Star State. The enormous expanse of the oil lands of California, which has been determined to extend almost the entire length of the State, would seem to indicate a supply of cheap fuel for the future in sufficient quantities to insure low-priced power for manufacturing industries of whatever nature that may arise. A glance at the statistics setting forth the productions of petroleum within the past few years will show the enormous increase that has occurred in the production of crude oil in the State of California. It has been estimated that the annual output under present conditions will not fall short of twelve million barrels per annum. The amount of power which could be developed from this source, together with the unprecedented development of hydraulic power for electric transmission purposes, should be amply sufficient for the needs of the present and prospective power consumers of California for years to come. It must be borne in mind, however, that should the consumption of fuel oil in railway and marine service continue to increase in the same ratio that has obtained within the last two years, there will be a demand far in excess of the supply, unless the latter is increased far beyond the twelve million barrels, and the consequence will be a rise in the prices which are now in vogue.

That the California fuel oil is a superior production for steam-producing purposes has been demonstrated by experiments recently made by the Naval Board at Washington. The tests made in these experiments involve the oils from the Pennsylvania and Texas fields, as well as those from California. The result was that California oil was demonstrated to have greater heating power than the products of the other states mentioned. The tests made disclosed the further fact that as a fuel for ships, California oil is superior to that of any other now in use. From this it will be seen that the eyes of the marine world will be drawn toward the California product, and that an increase of oil-burning in marine craft must be the inevitable result. The question naturally arises, if the demand exceeds the supply, whither will California look to meet the deficiency?

It has been amply demonstrated that water transportation is cheaper than transportation of any other character, and in view of this fact the large oil consumers now operating in this field have been casting about for new territory that may be developed to meet possible contingencies.

As against transportation charges by rail from the East, the cost of bringing oil from Alaska is mostly in favor of the latter. Enough development work has been done in the southern part of our northern possession to demonstrate the fact that it has probably a larger area of oil producing lands than any other country in the world. From Unalaska, the western port of Alaska, along the many islands skirting the southern shore, and on the main land as far as Juneau, it has been determined that oil exists in vast quantities. At Cold Bay, in the southwestern portion, within the past year the sum of half a million dollars has been invested by Colonel Delamar in

oil lands formerly located and owned by Captain Lathrop, who for many years was a steamship captain and pilot on the Alaskan coast. Generally speaking, the oil obtained is in every way similar to the California product. At Innerskin Bay large development work has been done by Eastern capital, with the result that a fine quality of oil of a paraffine base has been developed. The samples of this oil sent from the wells have demonstrated that as a lubricant and for refining purposes, Innerskin Bay oil has no superior. Outside of two other points in Alaska, the oil fields at Innerskin Bay are the only ones which have shown a paraffine product. At Kyak a lake of petroleum was discovered two years ago, and is now being thoroughly exploited. There are other fields which are going through the experimental stages, and the present outlook indicates that within a few years Alaska will be numbered as one of the great oil-producing sections of the world. It has been stated on good authority that the Standard Oil Company is interested in the Alaskan oil fields to the extent of one million dollars.

These facts are given merely to call attention to the nearness of an enormous supply of oil in case the California fields should fall short of the constantly increasing demand that is being made upon them, and they further accentuate California's favorable position which enables it to control facilities for continuing indefinitely in the production of the cheap power which it now enjoys.

California is at the present time one of the principal manufacturing states of the Union, and with the opening up of the markets of the Orient and the magnificent foreign trade development already apparent, with rapidly growing means of transportation across the Pacific Ocean, with instant communication secured by the laying of the trans-Pacific cable, and with the possession of the Philippine Islands, the Golden State is destined to become the seat of manufactured products sent from the United States to the Far East. The competition which of necessity must exist between the mechanical power derived from long distance transmission and that developed from fuel oil, will be sufficiently keen to keep the cost of power to the manufacturer down to a minimum, and such being the case, the position of California as a manufacturing state of prime importance is absolutely assured.

With these conditions prevailing, California can invite capital from the East with the full knowledge that few states in the Union offer the advantages that we enjoy.

THE NEXT CONVENTION —A FORECAST.

It is probable that despite the provision in the by-laws of the Pacific Coast Electric Transmission Association designating San Francisco as the place of holding the annual meetings of the Association, the next convention will meet on June 16-17th at the Hotel Rafael, in San Rafael, which, as is well known, is but an hour's journey from the metropolis. What is to be done during the session has not been definitely determined upon, for the executive committee has not found time as yet to go into the details of the proposed proceedings. One matter seems certain, however, and that is that the second section of Article IX of the constitution, stipulating that the annual meeting shall convene in San Francisco, must be amended so that the place of holding each specific annual meeting may be specially selected year by year. Contrast the enthusiasm of the Tamalpais and San Jose conventions with that of the last convention, which was held in San Francisco, and the reason for this necessity becomes apparent. The business attractions of other localities have no corners on quorums, which San Francisco certainly appears to possess.

There is plenty of subject matter for members to write about in forming papers for the coming convention, and, given the papers, there will be plenty for them to talk about in discussing them. For instance, who will present a paper on "The Engineering Organization of a Transmission Company," and who will present a companion paper on "The Commerical Organization of a Transmission Company?" A fruitful subject for discussion would be "Tangential Water Wheels Under Test and In Service." Then someone who knows might talk on "The Local Distribution of Transmitted Power." A forceful subject would be "The Reliable High Tension, Heavy Current Switch—Where is it?" Something unique and of invaluable interest might be offered on "Handling Heavy Machinery for Mountain Power Houses." "Steel Tower *vs.* Wooden Poles" could also be discussed with advantage, as could also "High Frequency Electric Power in Nevada County Mining." "The Trend of the Times," and "What the Year Has Taught" are two other good subjects. Here are the suggestions. Who will act on them?

Of course routine matter will come in for a goodly share of the discussions, for the report of the special committee on "Electric Shocks and Methods of Resuscitation Therefrom" will probably be forthcoming, and the worthy editor of the "Wrinkle Department" should have a fulsome store of problems and experiences from near and from afar with which to regale the convention. Hard shell nuts without number remain to be cracked on every hand; then garner the nuts and submit them to the editor aforesaid, for he is the "cracker."

It is, perhaps, not betraying secrets to intimate that a decided innovation will probably be introduced in the way of an outing for the second day, which will put to the away-backwoods any previous effort ever undertaken by any engineering or other gathering in the West. A special train, an afternoon session and banquet in the redwoods, and other delectable matters of that sort are talked about, and if they come, as they probably will, more genuine good in the way of an heart-to-heart interchange of experiences will result than could possibly follow a dozen formal conventions.

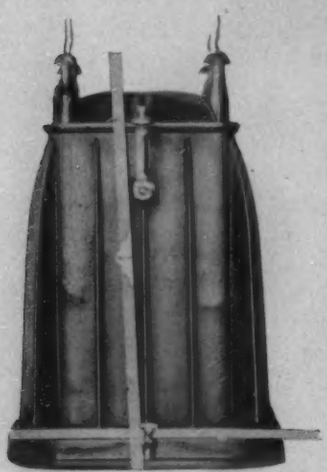
Be assured, then, that the forthcoming Seventh Annual Convention of the Pacific Coast Electric Transmission Association will be the most successful of any thus far held.

SOME RELICS OF THE POMONA PLANT.

OLD electrical apparatus of every description possesses a fascination to the student of electro-technics; but when that apparatus has an historic interest, and especially an historic interest of epoch-making significance, then its value increases many fold. Of such are the transformers of the old Pomona plant—that remarkable 10,000-volt single-phase transmission which was installed in southern California in 1892, and which, in addition to being the first 10,000-volt transmission in America, was the forerunner of the high tension transmission industry of this country. But the story of the plant is an oft-told tale* which need not be repeated here.

The original plant has now been dismantled, but its water rights, which have passed into the ownership of the Sierra Power Company, are now being utilized by it and constitute a portion of the power development system of the Pacific Light and Power Company, erstwhile the San Gabriel Electric Company, of Los Angeles. The old San Antonio Canyon station of the San Antonio Light and Power Company has undergone a change of location, the original pipe line has been extended so as to give a higher head, and, of the historic installation, the principal apparatus which is still in use are a number of the transformers that have been moved to Los Angeles and are doing duty in the operation of certain street lighting circuits.

In the accompanying three illustrations are shown the general features typifying the construction of these transformers. The cores have a width of six inches, by a depth of nine and one-half inches, by a height of thirteen and one-half inches, and the primary and secondary windings consist, respectively, of No. 10 and No. 8 B. & S. gage copper wire, wound in the manner shown in the initial letter. The inner one is the primary coil, after the manner of the early transformers, and the primary voltage was higher than the secondary, in the ratio of 2.22 to 1, or to be exact, the windings were in the ratio of 400 to 180. About these coils were placed the core punchings, which weighed nearly twenty-one pounds. A further peculiarity consisted in the placing of a copper plate all but entirely around the secondary coil, and in grounding this plate to the transformer case, which, in turn, was placed on grounded sheet iron strips.



Each transformer had a rated capacity of six and one-half kilowatts, and was oil-insulated, the leads being taken up through the transformer cover through paraffine-filled wood stands in the manner shown in the adjoining half-tone of the finished transformer.

Sawed redwood poles were used on this transmission line, they being thirty feet in length and measuring six inches by six inches at the top by ten inches by ten inches at the butt, and it is worthy of note that in rebuilding the line after ten years' of use fully 75 per cent. of the poles were found to be sound and thoroughly serviceable. The insulators used were of the well known Pomona type, in glass. These were supported by Klein's iron pins, and in taking down the original line the engineers were reminded of a detail of construction which had long since been forgotten—both the tie wires and the line itself at the point of tying were covered with leather.

*See, for instance, THE JOURNAL, Volume XIII, page 96, January, 1903.

WHY AMERICAN METHODS LEAD THE WORLD.*

BY GEORGE WESTINGHOUSE.

I WISH to thank our distinguished scientific friend, Lord Kelvin, for the complimentary language he has used about me. And I would like to say to all you railway men here present that my life has been very much associated with your calling. I invented the brake of which Lord Kelvin has spoken when I was scarcely twenty-one years old, and thus became acquainted with railway men when the railway industry was rather a poor one compared with what it is today. Since then I have closely followed railway operations, becoming acquainted with almost everything that is being done in them, and it is particularly my friendship with railway men which has prompted me to go forward in my work with an interest and keenness that probably would not have resulted from ordinary commercial motives.

Lord Kelvin has been good enough to refer to my coming to this country. I came here thirty years ago, and for ten years or so I was here about half the time. At that time it was very difficult to get any new thing done in England. I often wanted to sit down and cry, because I could not get anyone to believe in anything. I wanted, in those early days, to try an iron brake shoe, because, on account of rapid wear, we couldn't keep the wooden one adjusted. I had to beg and beg to be permitted to put a set of metal brake shoes on one tender on the Caledonian Railway. Finally, I succeeded. You all know, that nowadays, all the railway shoes or blocks are made of cast iron or other metal, and are used upon all the wheels of the train.

Lord Kelvin has alluded to American methods. May I say that one of your English difficulties is inherent, I think, in an old-world, highly developed country. After a man (or a nation) has worked prosperously for a long time, he opposes improvement or suggestion, thinking: What I have is good enough; I won't try a new thing. In America, however, the necessities have produced different results. Lord Kelvin speaks of England having sent many men to America. It has also sent to us many ideas. If you take up the American patent records, and follow the cases in litigation especially, you will find that among the references cited many are of English origin, some of them containing ideas so complete, the wonder is that the inventions disclosed were not established fully and completely in your own land. These records seem to show that Americans and Englishmen have invented the same thing many times.

In America, however, we have always been short-handed with regard to labor. We have been obliged to find methods whereby one man may accomplish the work of two or three men as compared with your practice here. We have had the best men from Europe—Englishmen, Germans, French, everybody—skilled men, highly trained men, as well as laboring men; we have combined their experiences with our own, coupled it with our necessities, and have thus accomplished results unattainable in a country like this, where you have more labor than you can well keep employed.

As an illustration of what has been accomplished by the use of electricity in a great industry, I may cite the Homestead Mills of the Carnegie Company. Mr. Schwab, whose name is well known to you, is a genius in his way, particularly in the management of

*During a dinner given at Claridge's Hotel, in London, on the night of January 9th last, Mr. George Westinghouse entertained a number of British railway engineers, managers, financiers and scientists, and two of the speeches delivered at the time were of interests. In the first, Lord Kelvin paid a tribute of praise to the genius of the great American inventor and manufacturer, after which Mr. Westinghouse replied in a speech of which an abstract is here given. —THE EDITOR.

men; he is a master in organizing and directing men. Mr. Carnegie believed in him, and if Mr. Schwab made a suggestion in regard to the use of new appliances, even if it involved the tearing down of an old mill and putting up a new one, the new one was ordered. What Mr. Schwab thought should be done was done. As a result of such progressiveness we may see the splendid mills at Homestead, where they produce with about 4,000 men three times as much steel as the Krupp Works produce with 15,000 men. The results are simply wonderful. You can start there today, in a building containing steel-melting furnaces, and you will there see three men mounted on a car with the charging apparatus, which is moved and operated by electricity. With a movement of this ingenious contrivance three men charge twenty furnaces which, prior to the use of electricity, would have required the labor of over 200 men.

You may go into the yard of the Homestead Mills, where they pile the metal in stock. This yard is covered with a system of overhead cranes, and the result is not only there, but in the mill, and in every other place, you may see great weights lifted and many undertakings going on without a single man exerting himself a bit—working not half as hard as I am working now.

I took some English friends to Homestead. Mr. Schwab, after guiding us through several departments, said: "I will now show you where we turn out 750 tons of plate girders a day." The mill was in the shape of an 'L'. We went into the short end of the 'L' where the furnaces were fed by natural gas, of course, requiring no stokers. The end at which we enterd had a rather low roof, and there was in sight a contrivance like a battering ram in front of the furnaces; two workmen were sitting down eating their dinners near by; no one else was present. I thought: Mr. Schwab has made a mistake; he has asked us to see a mill that is not in operation. But we went through the mill, which was about 200 feet long; and suddenly we heard a rattle and saw a truck approaching loaded with a big ingot. No one touched the truck or the ingot. The load came to a platform, the crane overhead dropped a pair of tongs, and quickly put the ingot on the roller table, and as it moved along to the great rolls, it was automatically kept in place. The adjusting screws of the rolls were turned by little electric motors, and not a man in that house did a bit of work. It was just as easy as what you are doing now—looking on! We went back to the furnaces. There was a fifteen-year-old boy seated in a little place called the "pulpit". He was able, merely by the movement of levers, to open at will any of the furnace doors and move the car along and we saw this car come in front of a furnace, and the charging machine approach and take out of the open furnace a hot ingot, which was dropped on the car and moved off to its work. There was this boy doing absolutely no hard work, and his mill was turning out 750 tons of steel plate each day. My English friends said: "England has no chance in competition with such methods."

Now, all this sort of thing came about in America because of our necessities. We hadn't men enough to do our work. There was a premium in favor of those who could invent machines to work, and thus supply the deficiency.

At the Carnegie Mills we went to see three blast furnaces. They were making 1800 tons of pig iron in twenty-four hours. We saw only two or three men on a truck, which was moved automatically. These men were letting the ore run from shoots and mixing it in the required quantity, and when they had filled a truck, it was carried up and its contents dumped into a furnace, whence it returned for another load. They were running the metal into an immense receptacle into which the metal from all three furnaces was mixed. From this place the metal was taken as required, put into a special tank, mounted on a car and taken to Homestead, two or three miles away, to be poured into the furnaces; one heating only was required.

I refer to all this simply to illustrate the immense advantages we have had in America, and the kind of experience I have been able to bring to this country, and to which Lord Kelvin so generously alluded, and which I hope will be not only useful and profitable, but will establish for the company I represent a name and a position which you will all regard as most satisfactory.

VICTORIA FALLS AS A SOURCE OF POWER.

IT has remained for a writer in a current number of an engineering magazine* to give authentic information concerning the wondrous Victoria Falls which were discovered when Dr. Livingstone reached the Zambesi, in November, 1855. From this authority it appears that the entire width of the falls is about a mile, the height is from 400 to 420 feet, as against 167 feet in Niagara Falls, and when the river is in flood, it is estimated that the volume of water is about double that of Niagara, giving about 35,000,000 horsepower as running to waste. During the dry season this is much reduced; but even in the driest years, the volume passing over the crest is very large. In the proposed electrical development of the falls the power house would be placed on a benching below the cascade, and would be supplied with water by steel tubes from the falls. Any amount of power required could be obtained, and an available head of at least 250 feet could be utilized. Each pipe or tube, eight feet in diameter, would drive a turbine and generator necessary for 5000 horsepower and it would probably be found desirable to lay down the plants in units of this magnitude. The ultimate site of the power house would have to be determined by the demand for electricity in the neighborhood.

Gold mines to the southeast, the coal mines of Wankie, and the important copper deposits in Barotse Land, which are believed likely to prove among the greatest in the world, would all require power to a very large extent. Chemical and metallurgical industries will be attracted, as they have been at Niagara, and if alluvial gold deposits exist, as reported, in the vicinity of the falls, they might be cheaply worked by hydraulicking.

Water would also be required for irrigation, and ploughing, sawing timber, and all kinds of agricultural work could be carried on by electrically-transmitted power. The great need for manufacturing on the spot all the various products which can be obtained by electrical energy is at once apparent when it is remembered that, at the present time, these have to be obtained from America and elsewhere, and transported thousands of miles, by sea and land, to the numerous points of consumption within a moderate distance of the Victoria Falls. In other words, both the necessary materials and the power are at the very doors of the Rhodesian population and need only to be properly developed.

PERSONAL.

MR. C. M. WOOD, who has for ten years past been connected with the California Electrical Works, of San Francisco, in the capacity of head of its sales department, has become president and manager of the Century Electric Company, the well-known engineers, contractors and supply dealers of San Francisco.

MR. JOHN F. KELLY, who needs no introduction to the electrical public, has associated with him Mr. T. W. Kloman and Mr. W. L. Fairchild for the conduct of a consulting and contracting engineering business, under the firm name of The John F. Kelly Engineering Company, incorporated. Mr. Kelly is president and consulting engineering of the company; Mr. Fairchild, vice-president and secretary, and Mr. Kloman, treasurer and manager. Like Mr. Kelly, Messrs. Fairchild and Kloman have been prominently identified for years with the Stanley Electric Manufacturing Company, the latter more recently as manager of the New York office and Mr. Fairchild as sales engineer. The new firm starts out with considerable transmission work in the West and in Mexico, and is understood to have strong financial support for any large projects it may undertake. Mr. Kelly, who will remain consulting engineer of the Stanley Instrument Company, has won his spurs in every department of electrical engineering, and since the development of electric power transmission has been a potent factor in that field, as the success of the several great installations he has planned abundantly testifies. As both Mr. Fairchild and Mr. Kloman unite strong business capacity with engineering knowledge, the combination is one which meets the conditions of the day, and a successful future for the new company can safely be predicted.

*Francis Fox, on "Electric Power in Darkest Africa," in *Cassier's Magazine* for April, 1903; Volume XXIII, page 683.

"THE WIRELESS," A LAND NEWSPAPER.*

THE only daily newspaper in the world publishing sure-enough dispatches transmitted by wireless telegraph had its birth yesterday morning at Avalon, Santa Catalina Island. The event is a unique one in the history of journalism and marks the beginning of an epoch in the dissemination of news in isolated places. The name of the infant journal is *The Wireless*, appropriately so called on account of the method by which it receives the news of the busy world. The unique sheet begins its career in the shape of a three-column folio, the exact size of the pages being 11 x 8 inches. In this convenient form is crowded, in addition to the local news of Avalon, an epitome of the local and general news appearing simultaneously in the *Los Angeles Times*, thus giving the residents of the island and visitors to its lovely shores a comprehensive synopsis of all the principal news of the world hours before the arrival of the steamer from the mainland with the Los Angeles paper.

SNOWFALL AND PROSPECTIVE WATER SUPPLY.

A LARGE number of reports have been received by the director of the California section of the United States Weather Burea showing the general distribution of snowfall in the mountains of California and prospective water supply up to March 15th. In general this season's snowfall largely exceeded that of last year, yet the approximate depth of snow at the beginning of March was less than usual. The supply of water will undoubtedly be much greater. The storms have been of such character that the run-off has been gradual and little waste of water has resulted. During the last half of March generous rains occurred in all parts of the State, but not at the same time. In southern California heavy rains have occurred since the reports published† were written, thus adding to the supply which was already ample. In the northern watersheds there have been no spring thaws, and the season is about three weeks late.

SAN FRANCISCO'S STREET RAILWAY MILEAGE.

MODERN journalism‡ has relieved the public of a millstone of anxiety concerning the mileage of the various street railway systems of San Francisco. The annual car mileage of the California Street Cable Railway Company's system is placed at 1,456,350, while that of the United Railroads is 18,797,500. As to the number of passengers carried, the Presidio line carries an average of 5,000,000, the California Street line an average of 9,000,000 and the United Railways an average of 182,500,000 passengers a year. Moreover, the latter concern runs 500 cars and employs 3,000 men, to whom it pays in wages the sum of $2,220,000 per year.

INDUSTRIAL.

NEW AND IMPORTANT PELTON INSTALLATIONS.

DURING the last four months, the Pacific Department of the Pelton Water Wheel Company has received contracts for water wheels for the largest and most important hydro-electric plants west of Niagara. In every instance the wheels must conform with the speed of the generators, to permit of direct connection, and as the heads under which they operate are of both extremes, viz., from sixty-five feet to 2100 feet, some idea of the adaptability and vast range of Pelton apparatus in this comparatively new industry may be imagined. These important installations may be briefly described, as follows:

The plant of the Vancouver Power Company, of Vancouver, B. C., will consists of three 3000-horsepower units giving 9000 horsepower as the maximum capacity of the plant. Each main unit will consist of two wheels, one to be mounted on each end of the extended generator shaft, wheels to operate under a 390-foot head and run at a speed of 200 revolutions per minute. The nozzles are of the improved Pelton combination hydraulically balanced, deflecting and needle types.

The Northern California Power Company, which has recently installed three 1600-horsepower Pelton wheels to direct connect to Westinghouse generators, has now given the Pelton company another order for two 3000-horsepower units to operate under an 1150-foot head. By means of flexible leather link couplings, power will be transmitted from both ends of each water wheel shaft to two 1500-horsepower generators, which will run at a speed of 300 revolutions per minute, making the maximum capacity of the plant to be 6000 horsepower.

The Gwin Mine Development Company of Valley Springs, Cal., is installing a hoist with a capacity of 20,000 pounds at a speed of 1200 feet per minute, the power being derived from two nine-foot diameter Pelton wheels having triple nozzles which are fitted with two hydraulic hoist-operating valves, one valve controlling the three gates on each nozzle. This will exceed the capacity of the famous Utica hoist, which consists of two ten-foot Pelton wheels and lifts 18,500 pounds from a depth of 2000 feet at a speed of 700 feet per minute.

The Siskiyou Electric Power Company, of Yreka, Cal., is about to install its first 1000-horsepower unit, which consists of one Pelton wheel operating under a 689-foot head, which will be direct-connected to a 750-kilowatt generator by means of a flexible leather link coupling.

Contracts for an interesting plant have just been let to the Pelton company by the Pikes Peak Hydro-Electric Company, of Colorado Springs, Colo., which, when finished, will be the highest in the Western Hemisphere, both in altitude and operating head for the wheels, the effective head being 2100 feet. The plant will consist of three Pelton wheels each direct-connected to one 750-kilowatt generator which will run at a speed of 450 revolutions per minute. The whole construction of these wheels will embrace the highest grade of steel and United States Navy standard gun metal.

Other contracts aggregating 2000 horsepower have either been installed or ordered during the last three months, and may be summarized as follows: Iowa and Mexico Mining and Milling Company, Tepic, Mexico; Gwin Mine Development Company, two six-foot wheels for running its rock-crusher plant (300 horsepower, 290-foot head, 217 revolutions per minute); Brigham City Electric Light and Power Company, Brigham City, Utah (800 horsepower, 280-foot head, 300 revolutions per minute); Corrigan, McKinney & Co., Concheno, Mexico (150 horsepower, 190-foot head, 85 revolutions per minute); Kerkhoven and Mazel, Pasir Naugka, Java (800 horsepower, 36-foot head, 76 revolutions per minute); Oregon Developing Company, Cascades Calumet Manufacturing Company, Castle Rock, Oregon, besides many others of smaller capacity requiring standard wheels.

MOIS SCIENTIFIQUE ET INDUSTRIEL.

NOTRE confrere le *Mois Scientifique et Industriel*, 8 Rue Nouvelle a Paris, nous informe qu'il a decide de publier, cette annee a titre de Supplement, quatre Monographies tres documentees avec Index Bibliographique sur divers sujets.

La premiere sera relative a la Fabrication des Fontes, Aciers et Fers par le Haut Fourneau Electrique.

Elle contiendra un grand nombre de croquis et de dessins, et sera suivie d'observations critiques par diverses personnalites. Elle paraitra dans le fascicule du 25 Mars.

La deuxieme Etude trimestrielle aura pour titre: Les Applications Industrielles du Froid, et paraitra le 25 Juin.

Nous rappelons que cette Revue se trouve dans toutes les Bibliotheques des Gares, le prix de chaque fascicule est de 2 francs.

The Stanley Electric Manufacturing Company, through its Montana office, has sold to the Bismark Nugget Gulch Consolidated Mining Company a complete equipment consisting of inductor alternators, induction motors, hot wire voltmeters and ammeters, lightning arresters and the attendant controlling and regulating apparatus,

*From the *Los Angeles Times* (Cal.), March 26, 1903.

†See *Climate and Crops, California Section*, March, 1903.

‡*San Francisco Chronicle*, Sunday, February 15, 1903, page 9.

RECENT LOMBARD GOVERNOR SALES.

JUDGING by a report recently received from The Lombard Governor Company, of Boston, practically all the power transmission companies of the country must be using Lombard waterwheel governors and accessory apparatus in their plant extensions, for the list of names submitted as indicative of the orders received during a single month reaches every section of the country as well as every size of power plant. For instance, type "B" Lombard governors were sold to the Cascade Electric Company, of Berlin; the Ware Sholes Manufacturing Company of Laurens, S. C.; the Lynchburg (Va.) Water Power Company; the Public Works Company, of Bangor, Me.; the Zanesville (O.) Electaic Light and Power Company; the Canadian Electric Light Company, of Levis Que; and the Sacramento (Cal.) Electric, Gas and Railway Company. Type "F" Governors were sold to The Edison Electric Company, of Los Angeles, Cal.; and Messrs. Victor M. Braschi & Bro. of the City of Mexico, while a type "O" governor was sold to the Brattleboro (Vt.) Gas Light Company, and a type "G" governor was sold to the Niagara Falls (N. Y.) Power Company. The purchasers of type "D" governors were the Nasonville (R. I.) Woolen Company, the Athens (Ga.) Electric Railway Company, the Ludlow (Mass.) Manufacturing Associates, the Sebastcook (Me.) Power Company, and the Valley Counties Power Company, of San Erancisco. The Lynchburg (Va.) Water Power Company purchased several Lombard electric speed controllers, as did also the Bangor, Zanesville, Sacramento and San Francisco companies named, while the Ware Shoals Manufacturing Company equipped its pipe lines with the new Lombard hydraulically-balanced relief valves, of the type that are already in use by the Washington Water Power Company, of Spokane, Washington.

NEW KILBOURNE-CLARK AGENCIES.

UP in the Puget Sonnd country and thereabouts, even including Oregon, Idaho and Montana, the name of the Kilbourne & Clark Company, of Seattle, Wash., is as a houseword to buyers of electrical machinery and supplies, but it is only within recent months that it is becoming intimately known to the electrical interests of California. The commodious head offices and showrooms of the Kilbourne & Clark Company, situated at Nos. 815-817 Second Avenue, Seattle, constitute one of the most complete electrical establishments in the Pacific Northwest, and it is intended that the location of the headquarters for its California business at 519 Mission Street, San Francisco, shall prove to be the inception of an equally important concern in the Golden State.

As a result of an Eastern trip recently made by W. G. Clark, vice-president and general manager of the company, the line of agencies carried by the Kilbourne & Clark Company has been materially enhanced in value, so that now there are listed among its more important accounts those of the Nernst Lamp Company, of Pittsburg; the Christensen Engineering Company, of Milwaukee; the Stromberg-Carlson Telephone Company, and the Cutler-Hammer Electric Company. In addition, coast agencies are held for the Warren Electric Company, the Electric Porcelain Company, of East Liverpool, O.; the Eureka Flexible Conduit Company and the United Electric Heating Company. Yet other agencies have been secured, prominent among which is that of the De Forest Wireless Telegraphy Company, for which a contract has been secured by the Kilbourne & Clark Company for the erection of wireless telegraph stations at Cape Flattery, Nome, Dutch Harbor, Kamschatca and in Siberia.

THE NERNST LAMP IN SALT LAKE CITY.

The Salt Lake Electric Supply Company, Utah agents for the Nernst Lamp Company, of Pittsburgh, Pa., has recently secured the lighting contract for the large department store of the Keith-O'Brien Dry Goods Company, of Salt Lake City. There were several competitors for this contract, but the Nernst lamp won.

"CHLORIDE" BATTERIES AND "SPARKING" CELLS.

THE Electric Storage Battery Company, of Philadelphia, manufacturer of the "Chloride Accumulator," has recently installed and has in process of installation a number of large batteries for railway work. Among these may be mentioned two batteries contracted for by the United Traction Company of Albany, each having a capacity of 700 kilowatts. These will be located at Albany and Troy respectively, and are operated in connection with specially wound boosters for regulating such fluctuations as may occur in the load.

The Cleveland, Painesville and Eastern Railway Company is soon to install a battery having a capacity of 460 kilowatts, which will be operated in connection with a motor-driven differential booster. This installation is designed to relieve the station of fluctuations, to care for peaks and allow the station to be operated with fewer generators than are now in service.

The company, which is also manufacturer of the Exide Battery for electric vehicles, has recently placed on the market a new battery for sparking purposes. The great increase in the use of gasoline vehicles has created a demand for a reliable sparking battery which will furnish a "fat and hot" spark, and to satisfy this demand the company has placed on the market a number of sizes, which are fully described in a recently-issued pamphlet giving capacities, weights and dimensions of the different types. A copy of this will be forwarded upon application to the Electric Storage Battery Company at any of its sales offices.

CONCERNING GRAPHITE COMMUTATOR BRUSHES.

ALL generators made up to five or six years ago were provided with copper brushes, but as the size of generators increased and it became necessary to introduce solid armatures, it was found that the copper brushes had such a low contact resistance that it was practically impossible to so design the machines that they would not spark on wide variations of load. Experiments were then made with a view of obtaining a material that would have a greater resistance, and, after many trials, carbon with a small admixture of graphite was adopted and is now used very universally. By the virtue of its high internal resistance, the carbon brush cuts down the current in a short-current coil to a low value, and in consequence gives sparkless commutation. Machines of a size and voltage which would have been prohibited if copper brushes were used can now be built with absolute certainty.

Because of the very much greater smoothness of graphite, graphite brushes are now quite rapidly taking the place of the hitherto favored carbon brushes. Dixon's Graphite Brushes have been pronounced superior to anything in the way of graphite brushes that have heretofore been made.

NERNST LAMPS AT THE CIRCUS.

THE Barnum & Bailey "Greatest Show on Earth" has recently arranged for seventy Nernst lamps, ranging in size from the one-glower to the six-glower type, for the purpose of illuminating its large canvas pavilions, literally turning night into day and enabling everyone to see the smallest objects at a great distance, and with a quality of light which is the nearest approach to daylight of any that is produced by artificial means. To furnish current for operating the Nernst lamps, Barnum & Bailey have purchased special engines to generate power. They will, also, use the Nernst lamps exclusively for display advertising.

A GREAT INTERLOCKING INSTALLATION.

A contract for the largest interlocking installation ever placed in America, and probably much the largest in the world, has recently been given to the Union Switch and Signal Company for the St. Louis Terminal. The Westinghouse electro-pneumatic system will be adopted, and the contract calls for 258 working levers with fifty-one spare levers, which will perform 748 functions.

SOME NEW BATTERY INSTALLATIONS.

THE Electric Storage Battery Company of Philadelphia, manufacturer of the "Chloride Accumulator" has recently closed several large contracts for the installation of storage batteries in connection with street railway work on the Pacific Coast.

The Los Angeles Railway Company has contracted for three batteries, each consisting of 264 cells, two of which have a capacity of 1000 amperes and one having a capacity of 2000 amperes. These batteries are to be operated in connection with differential boosters for the purpose of regulation on the railway load and for reserve in any emergency which may arise due to the temporary shut down of machinery at the power house.

The Pacific Electric Railway Company of Los Angeles has also contracted for a battery of "Chloride Accumulators" consisting of 264 elements of 1000 amperes capacity to be operated in connection with a differential booster for regulation, peak work and emergency use.

Several batteries are now also in process of installation for the Oakland Transit Consolidated, the Los Angeles Pacific Railway Company and the North Shore Railroad.

PACKING GAS ENGINE CYLINDER HEADS.

AN interesting leaflet entitled "How to Pack Gas Engine Cylinder Heads" has just been issued giving full directions for cutting gaskets, preparing the flange and applying the gasket, so that the most efficient service may be obtained. The difficulty of packing cylinder heads of gas engines for stationary, launch or motor service has been one of the discouraging features in the use of these engines, but nevertheless the methods described in the leaflet have been proved by years of experience to be the only successful way to avoid these difficulties and secure the best results. Anyone interested can secure this leaflet from H. W. Johns-Manville Company, 100 William Street, New York, or its branch offices in Milwaukee, Chicago, St. Louis, New Orleans, Pittsburg, Cleveland, Boston, Philadelphia and London.

TO THE ELECTRICAL CENTER OF SAN FRANCISCO.

AN evidence that the center of the electrical business of San Francisco is gravitating toward the south of Market Street is found in the fact that of late there has been a general exodus of electrical concerns from such well-known buildings as the Mills and Haywards Buildings to the new structures that have recently been erected in the vicinity of the Palace Hotel. Prominent among these concerns is the Wagner-Bullock Electric Company of California, which, in conjunction with the Pacific Coast office of the General Incandescent Arc Lamp Company, has taken the ground floor corner of the new Rialto Building on the corner of New Montgomery and Mission Streets, while The Charles F. Sloane Company has engaged larger and more commodious offices occupying the second floor corner of the Crossley Building, situated diagonally opposite the Rialto Building. The Crossley Building, which is better known as the "Old Wells-Fargo Building" is under reconstruction and enlargement, and when it is finished, which will be about August 1st, The Charles F. Sloane Company will move from its present quarters in the Mills Building.

A FLATTERING INDORSEMENT.

Joseph Dixon Crucible Co. September 23rd, 1902.
Jersey City, N. J.

Gentlemen We have been using Dixon s Silica-Graphite Roof Paint for the past six years and will say that it has been perfectly satisfactory to us If you keep up the high standard in the future that you have in the past we would not think of using any other paint for that purpose. We think that it is especially serviceable along the seashore. Very respectfully.

IJR.

THE ELBLIGHT SYSTEM IN SAN FRANCISCO.

ONE of the most striking pieces of electrical work of a decorative nature to be found among the hundreds of installations that adorn the streets of San Francisco at night, is the exterior and window installation erected by The Standard Electrical Construction Company, of San Francisco, in and about the building housing the new department store of Messrs. Weinstock, Lubin & Co., on the corner of Geary Street and Grant Avenue. The difficulties attending night photography, especially of multi-colored subjects, make it impossible to convey more than a suggestion of the beauties of an installation of this character, which beyond doubt represents the highest refinement yet attained in the art of exterior decorative illumination. The electrical materials used throughout are those comprising The Elblight System, pictorially detailed in the advertising pages of recent issues of THE JOURNAL, and as more fully described on page 121 of its Annual Edition in January last.

It has been the consensus of opinion of the thousands who have admired the beauties of the Weinstock-Lubin installation that no more fitting method of illumination could be devised for the night decorative features attending the coming reception of President Roosevelt, nor for the annual encampment of the Grand Army of the Republic, to be held in San Francisco in Augnst next, than is to be found in the remarkably flexible and beanteous system of the Elblight cables.

LIP